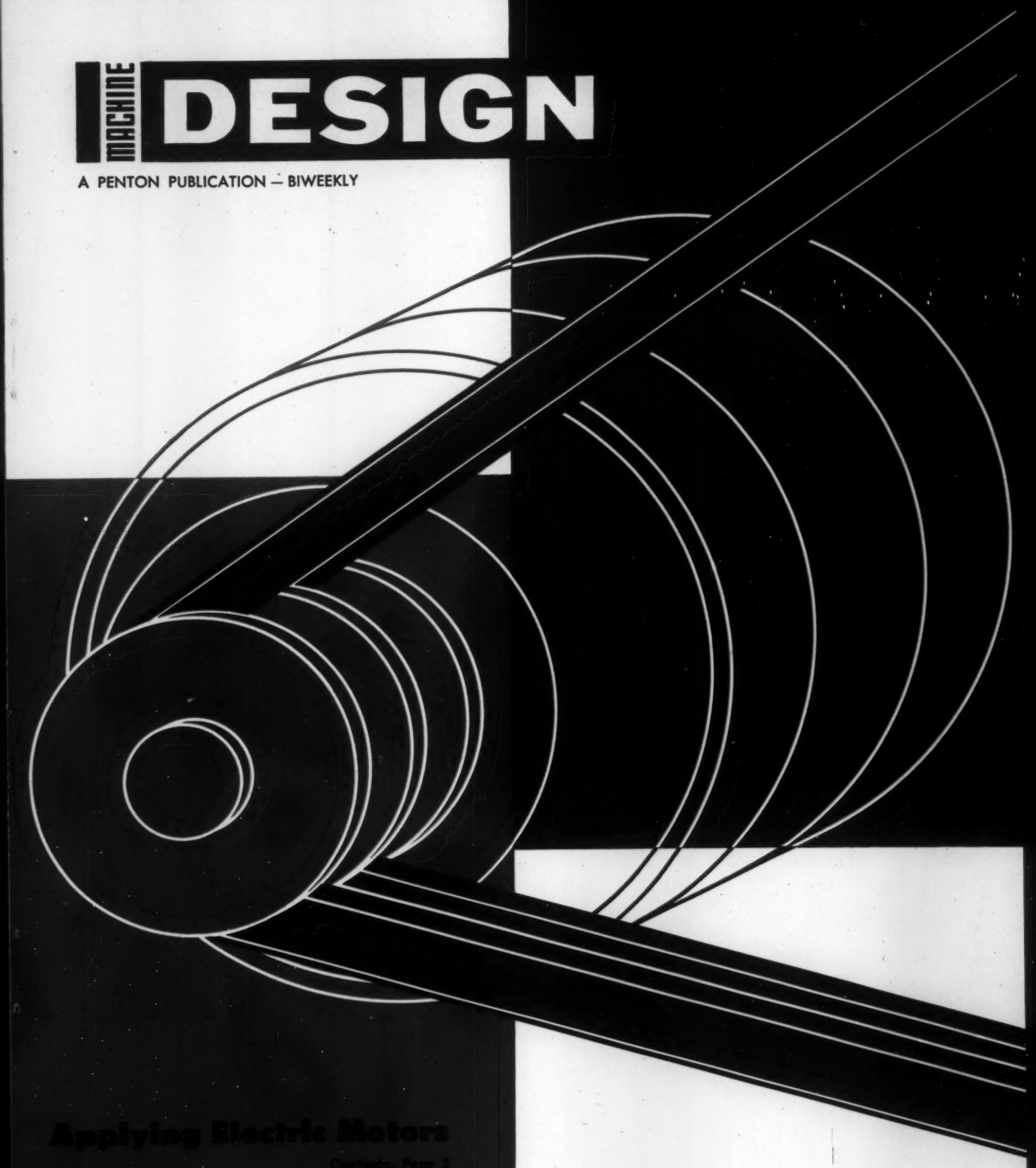
MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY



Applying Electric Motors

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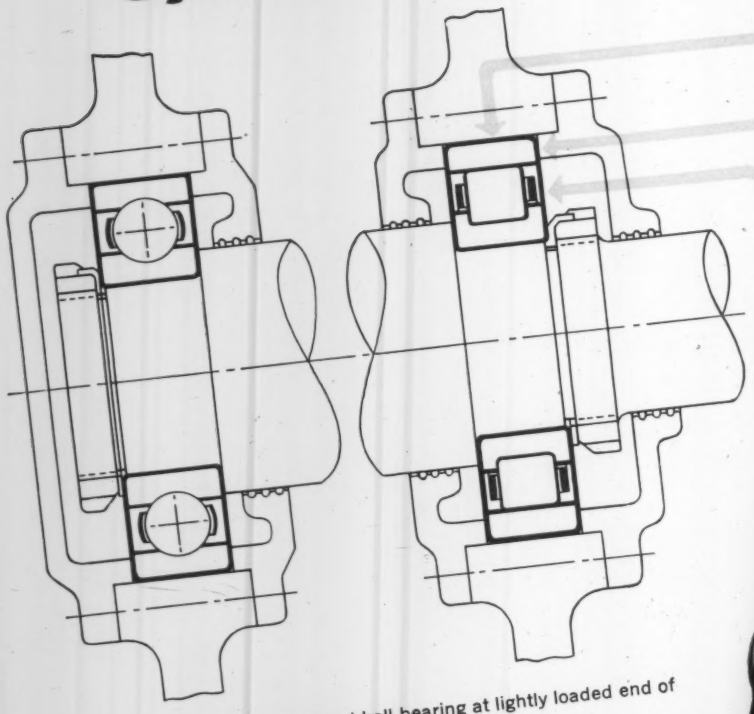
For Shaft Expansion and/or Heavy Radial Load...

Use NORMA-HOFFMANN PRECISION Cylindrical Roller Bearings

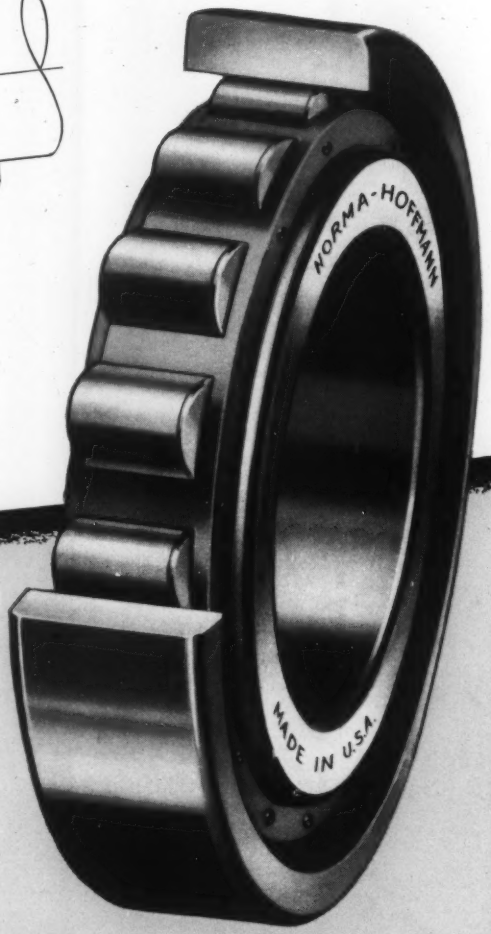


Outer ring mounted with tight fit in housing.

Outer ring rigidly clamped endwise (no looseness or slippage in housing).

Rollers move endwise as shaft expands.

Typical mounting using clamped ball bearing at lightly loaded end of shaft and clamped roller bearing at heavily loaded end.



CHECK THESE ROLLER BEARING ADVANTAGES:

1. No looseness required between outer ring and housing — as with self-contained bearings.
2. No possibility of endwise cramping of bearings — a frequent cause of heating and early failure.
3. Extra quiet and trouble free operation — due to elimination of looseness.
4. Extra heavy radial load capacity plus resistance to shock and vibration.
5. Precision limits held throughout permit extra high speed operation.
6. Interchangeable with standard single row metric ball bearings.
7. Available also in several extra light series where overall weight is important.

Norma-Hoffmann Engineers, specialists in bearing design and application, will help you with your problems. Ask for their services or write for catalog.

precision ball, roller & thrust bearings

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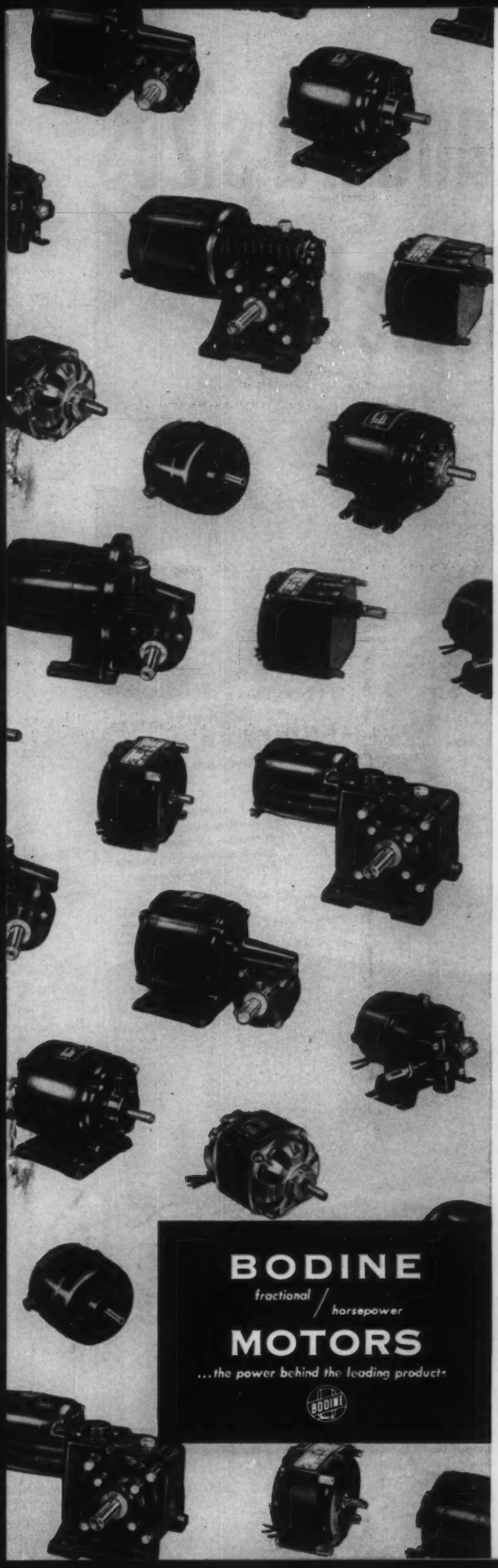


NOW!

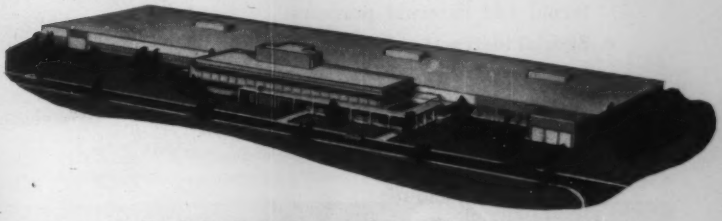
only 12 to 16 week delivery on fractional horsepower motors

Now and in the future, faster delivery . . . 12 to 16 weeks . . . on Bodine fractional horsepower motors built to order! Why? Bodine Electric Company has transferred its manufacturing operations into this spacious new plant. Vastly expanded production facilities . . . improved production methods result in much faster and more efficient production . . . without sacrificing one iota of Bodine's reputation for building *the quality* motor of the industry.

And the added production and warehousing facilities make it possible for Bodine to offer more than 265 different standard, stock types and sizes . . . ready for fast shipment.

You also get much faster delivery on your built-to-order sample test motors and reducers for prototypes . . . five to six weeks for standards . . . five to nine weeks for specials that do not require engineering or testing . . . and only eight to twelve weeks for those requiring special engineering and testing.

For more information, contact Bodine Electric Company, 2258 W. Ohio St., Chicago 12, Ill. ... or check your Sweet's Product Design File.



New Bodine Electric Company plant on Chicago's northwest side

Bodine builds fractional horsepower motors for manufacturers of: adding machines, letter openers, sanders, vending machines, exhaust fans, duplicating machines, hand dryers, portable tools, sound recorders, air conditioners, check protectors, respirators, voltage regulators, X-ray timers, traffic signal timers, stirrers, calculating machines, envelope sealers, and for many other applications.

Circle 404 on Page 19

Now you can get standard sizes in C/R End Face Seals!

Chicago Rawhide now announces the availability of a complete new line of Standard End Face Seals to meet the widest possible range of sealing requirements. For sizes or conditions beyond the range of Standard End Face Seals, C/R engineers will continue to cooperate with you on special designs. Their experience in sealing applications is unmatched — your assurance of getting the correct seal for the job.

Write for your free copy of this new C/R Bulletin →

Bulletin EF-100 includes complete envelope space data on C/R Standard End Face Seals and mating rings to help you select the correct size for your equipment design:

- Size range table in two series — long and short — from ¾ to 4 inch shaft diameter.
- Size range table on mating rings.
- Typical seal installations for internal and external pressure.
- Special instructions on how to order.

C/R
STANDARD
END FACE SEALS
maximum sealing efficiency in minimum space
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pressures to 500 psi.
temperatures to 500° F.
peripheral speeds to 15,000 FPM.
external or internal pressures
2 complete series . . . long and short . . . pre-engineered to meet the widest possible range of sealing requirements. Standard mating rings also available.
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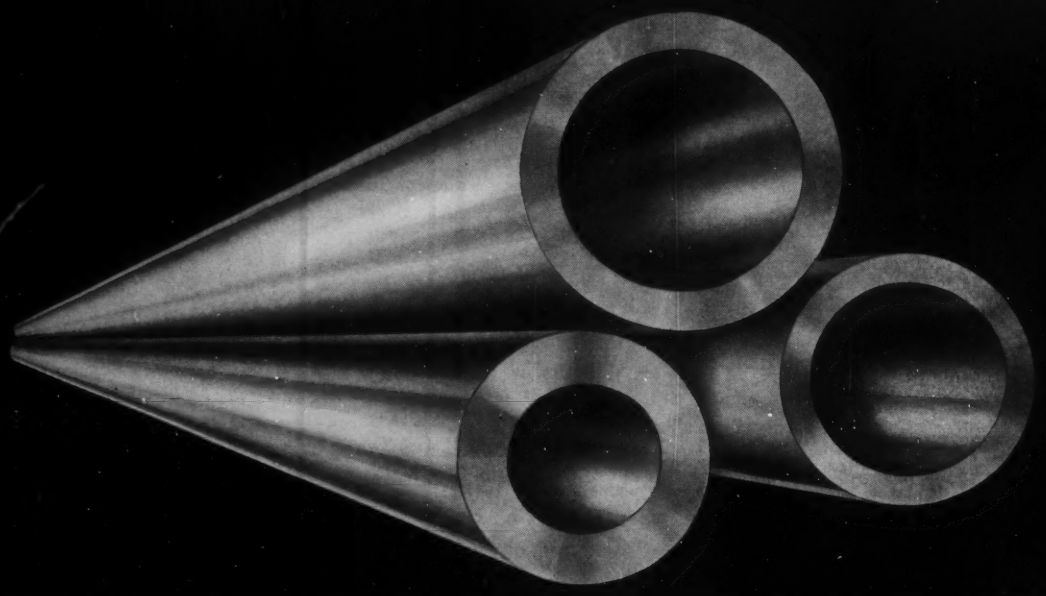
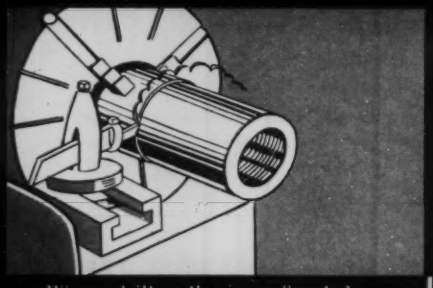
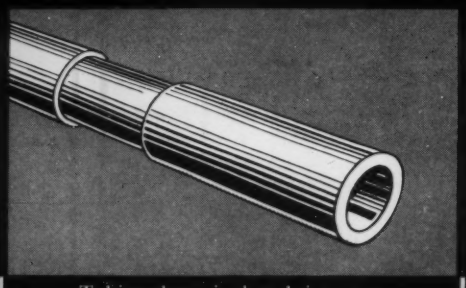
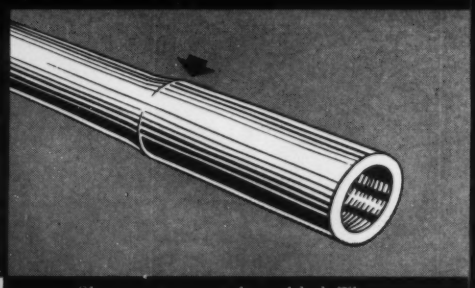




Worn drill collars are "peeled down" for perfect roundness, eliminating surface scars and imperfections.



Tubing sleeve is shrunk into perfect position.



Sleeves are securely welded. Thus drill collars go back into service actually as good as new.

MATCHING TUBES TO JOBS

Drill collars and tool joints can't last forever in oil well equipment service. Abrasive wear reduces the strength and the safe minimum O.D., and makes the bearing faces eccentric. When so worn, they are repaired by using sleeves—as shown above. One producer of such equipment brought a problem to B&W—"How could this 'sleeve' job be done with a minimum cost in equipment, operations, material and time?"

Because of the diversity of its types of tubular products and experience in matching tubes to jobs B&W was able to supply tubing in the proper type, size and grade and with appropriate tolerances and physical properties. This, in turn, reduced the number of fabricating operations and eliminated excessive machining and the need of some fabricating equipment. This manufacturer was able to "repair and place in as good as new condition" these rather expensive products—and at a substantial reduction in cost.

Friendly Mr. Tubes—your link to B&W—is the man to call when tubing can save the day in your own operation. His business is matching tubes to jobs—jobs like yours. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-6106-M6

Seamless and welded tubular products, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels.

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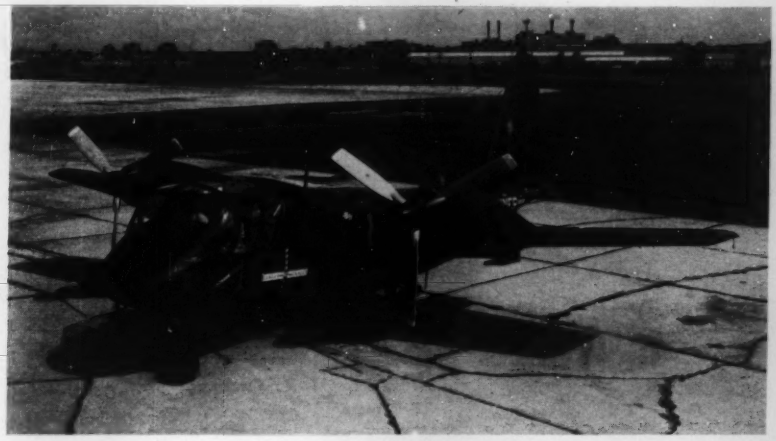
Engineering News Roundup



ARMY'S FIRST TURBOPROP, the two place Grumman AO-1 Mohawk, will be used for tactical reconnaissance by both Army and Marines. It represents the first joint Army-Navy effort to develop an aircraft to meet common requirements. Wingspan is 42 ft, length 42.5 ft. Lycoming T-53-L-3 engines are fitted with reversible Hamilton Standard Hydromatic propellers. Takeoff power is 1005 shp at each engine. The new plane can be fitted with skis for operation from unprepared fields and in mud, snow, and water.

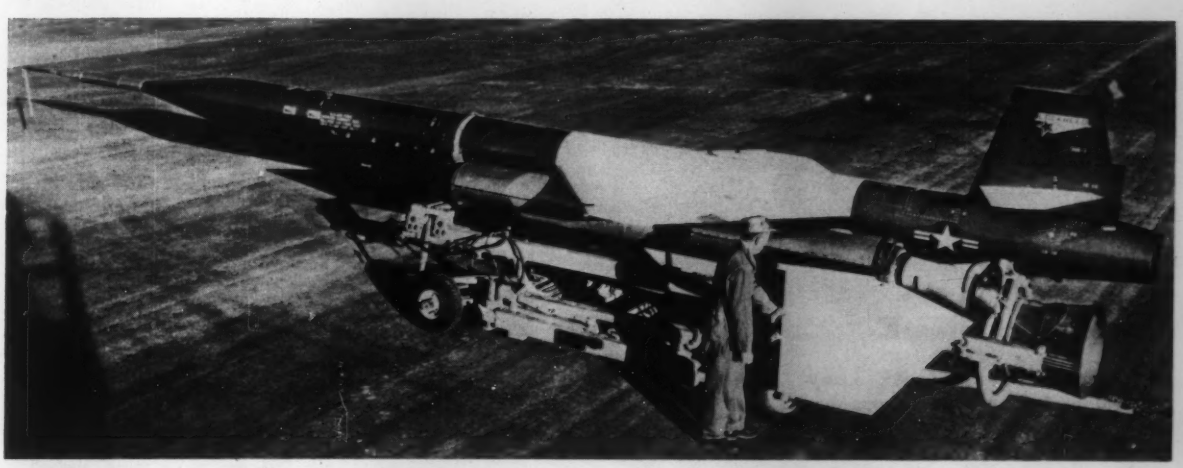
Scientist Predicts Revolution In Way of Life by Year 2000

Fuel Consumption, War Power, Automation Described as Factors

NEW YORK—A "tremendous revolution" by the year 2000, staged by scientists and engineers, was forecast recently by Dr. J. H. Rand, president of the Rand Development Co. Progress is now "exploding in logarithmic fashion," he said.

He pointed out that half of all the oil consumed by man has been consumed in the last 25 years; the Strategic Air Command, in one raid, can drop more explosive power than was expended in all of World War II; speed of the airplane, since 1910, has increased from 100 mph to 2000 mph.

The farmer, he said, leads in automation. Milking machines and



SUPERSONIC BULLSEYE, Lockheed's Q-5 target drone, will reportedly travel more than twice the speed of sound, making it the fastest target vehicle in service. In contrast to subsonic targets now in use, the new drone should provide a more realistic gauge of weapons capabilities. The Q-5 is 39 ft long, has a wingspan of 10 ft, diameter of 20 in., and weighs more than 7600 lb. Ramjet powered, it is air-launched at high altitude or ground-launched with rocket boosters. Recovery is accomplished by steering the drone over a sandy area and letting it down by parachute until its dart-like nose sticks in the sand. The Q-5 is instrumented to score near misses and theoretical hits without itself being destroyed.

conveyor belts for chicken and egg production are now commonplace. He predicted that farmers will one day control tractors from a central station where they will view machine operation on TV screens.

He discussed progress in the transformation of waste products: "Already in the U. S., refuse waters from paper production are being utilized indirectly for human consumption. We are able, by the use of heat and acid, to convert cellulose into a digestible sugar . . . thus making the waste water of paper production and sawdust convertible into a sugar, which in turn is the basis for yeast growth and produces protein and vitamin enriched foods."

FUNCTIONAL STYLING of International's new Sightliner truck tractors includes floor-level, tinted-glass windshields. The new line features an exceedingly "slim profile"—48 in. from bumper to back of cab. This is about 31 in. shorter than current cab-over-engine models, and permits use of longer trailers without exceeding overall length restrictions. Maneuverability is improved, particularly in city operations. The new truck is available in gross weight ratings from 24,000 to 30,000 lb. Sleeper cab, power steering, and a selection of springs are among options available.

Army General Lists Four Aims for Photo Research

ASBURY PARK, N. J. — An Army general, speaking to photographic scientists, set forth four research goals:

1. Films for night photos.
2. All-dry photo process for battlefield use.
3. Film sensitive to light but unaffected by nuclear radiation.
4. An automatic means for selecting photos from file and processing of essential information.

Brig. Gen. Earle F. Cook, commanding officer, Army Signal Engineering Laboratories, Fort Monmouth, N. J., in an address before the Society of Photographic Scientists and Engineers at their annual conference, also cited military advantages of photography. He said that comparatively light and compact equipment provides a permanent record for expert examination and high resolution for detection of targets.

Castings Press-Forged For Greater Strength

DAYTON, OHIO—Better mechanical properties and greater ultimate strength of aluminum, magnesium, and titanium castings are obtained by press forging and then aging. This cast-forging method, developed by the Armour Research Foundation, is intended to increase the use of forged castings instead of forgings and fabricated parts. This would result in lowering aircraft costs.

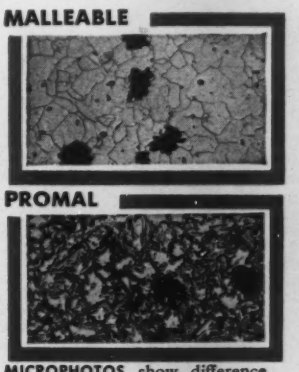
The cast-forged process used on aluminum 356, under varying conditions, showed improvements in yield and ultimate strength but a reduction in elongation. A forging temperature of 400 F was found suitable for magnesium AZ 92. This material is improved markedly by press forging. Results of press forging aluminum alloy 220 showed a great increase in strength and little loss in ductility. Cast bars of titanium (6Al-4V) were press forged to determine the forgeability of this material. A forging temperature of 1400 degree F greatly limits the benefits likely because of being so close to the recrystallization temperature.

A cast magnesium level arm, used as an elevator control arm in T-34 aircraft, was chosen to demonstrate the increases in strength that could be obtained by press-forging. The casting was redesigned slightly to adapt it to press forging. Six of the castings were press-formed with a 17 per cent deformation. The ultimate strength and the yield load were increased by plus 17.7 per cent and plus 39.5 per cent respectively.

Front Cover

Design of an electric-motor drive system first requires a sound analysis of the mechanics of the system. This factor in applying electric motors is accented on George Farnsworth's front cover to highlight W. R. Harris' article on Page 109.

Specify longer-lasting Link-Belt Promal chains for extra durability



MICROPHOTOS show difference between ordinary malleable iron and Promal. Upper—white areas in malleable microphoto represent "free-iron". . . black shows soft nodules of carbon. Lower—the dark areas in the Promal structure show stronger, stiffer reinforcing material which strengthens metal and resists distortion and wear.

◀ **UP TO 475 TONS** of steel mill scale a week are recovered by this Link-Belt system. Class 700 Promal chain on Straightline Collector moves scale from settling tanks to discharge conveyor. Promal is especially suitable for long heavy-duty conveyors and elevators.

Specially heat-treated malleable iron provides extra wear resistance

Fewer conveyor shutdowns and minimized replacements are economies realized by users of Link-Belt Promal chain. Its greater strength absorbs continuous impact loads — and wear resistance supplies the durability to cope with severe abrasion.

Promal is more than a partially annealed or surface-hardened malleable iron. Developed by Link-Belt, this specially heat-treated malleable iron is actually transformed into a metal of radically different physical properties. Promal, because of uniform micro-structure throughout its whole section, provides greater ultimate strength, higher yield point, exceptional fatigue resistance and a remarkable capacity to withstand abrasion.

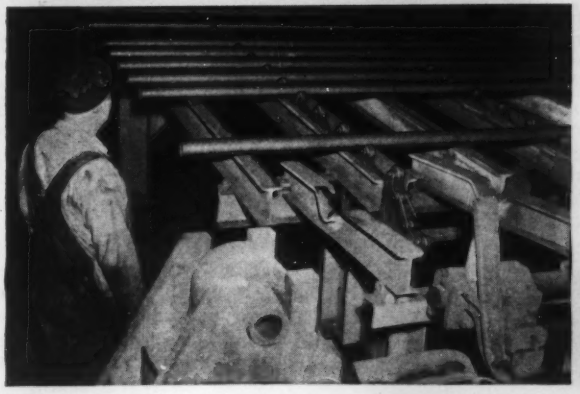
For unusually abrasive or mild corrosive conditions, Promal chain can be furnished with "file-hard" surfaces. Copper bearing or special alloy content also available.

Where and how to apply Link-Belt Promal Chains

Choose Link-Belt Promal chains for highly abrasive conditions—for extra strength and wear resistance demanded by heavy loads or long, sliding conveyors. They last much longer . . . cost but a little more.

The wide range of Link-Belt chains available in Promal includes all types of cast and combination chains.

HEAT-RESISTANT PROMAL is recommended for temperatures up to 1000 F. This SMGL-618 Promal chain conveyor with riser attachments picks up and conveys sheet steel through furnace. Chain has operated continuously for two years without failure.



Promal chain controls uniform cooling of pipe

An inclined conveyor, using Link-Belt Class 1100 Promal chain with attachments, permits an Ohio steel mill to control cooling of longer tubes than previously possible. Pipe is received from hot finishing operations at temperatures up to 1800 F. Controlled chain speed permits uniform cooling of outer tube periphery.

HEADQUARTERS for chains, sprockets and other Link-Belt conveying and mechanical power transmission products is your nearby Link-Belt office.

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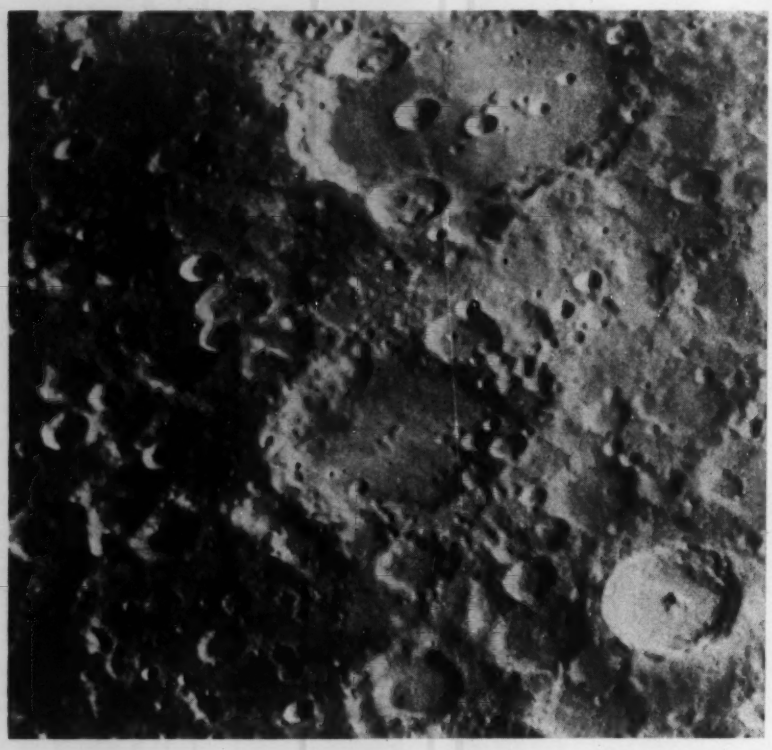
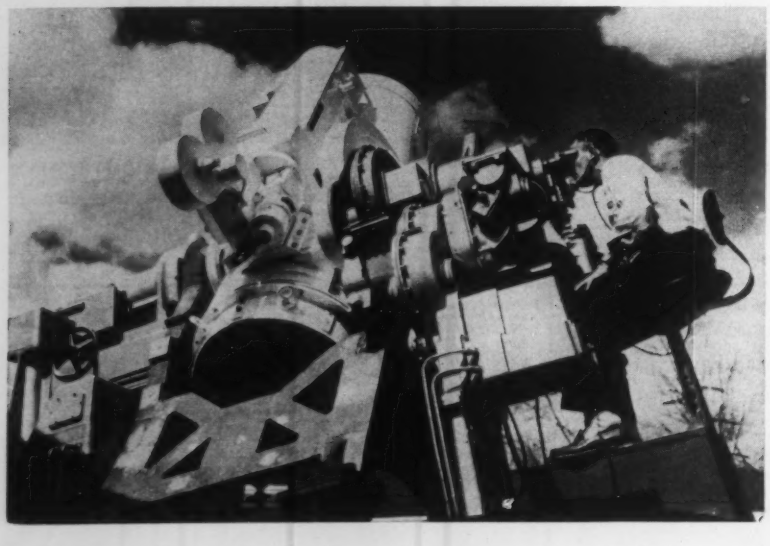
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.281-A



CRATER-POCKED MOON'S SURFACE is seen through eye of giant missile tracker. Mounted on Navy 5-in. gun mount, recording, optical-tracking instrument was designed by Perkin-Elmer Corp. for tracking missiles in early stages of flight. It will permit Air Force to measure missile travel with greater accuracy after launching from Cape Canaveral, Fla., launching site. The giant tracker consists of 24-in. primary telescope, sighting telescopes, camera, and associated equipment. Primary telescope has five focal lengths from 100 to 500 in. It is 2 ft in diam, 8 ft long, weighs a ton, and has 200 different optical elements. Information from radar and other communication nets will be fed into the station when a missile is fired. Computers will convert this into signals that will activate the missile tracker.



Topics

Do-it-yourself justice dispenser for violators of parking regulations resembles a parking meter. The Collectall receives quarters and half dollars in payment of a parking fine, cuts off and retains a portion of the ticket and perforates the word "paid" on a receipt stub. American Bank Equipment Co., manufacturer of the Collectall, suggests locating the "curbstone courthouses" on sidewalk posts or in building lobbies.

• • •

Atomic locomotives will compete with diesels in 1970, according to Edward J. Kehoe, formerly associated with AEC. In a speech before the Ninth Panamerican Railway Congress, Mr. Kehoe predicted that an atomic locomotive will be in operation by 1960 and ten years later should be economically competitive with diesels.

• • •

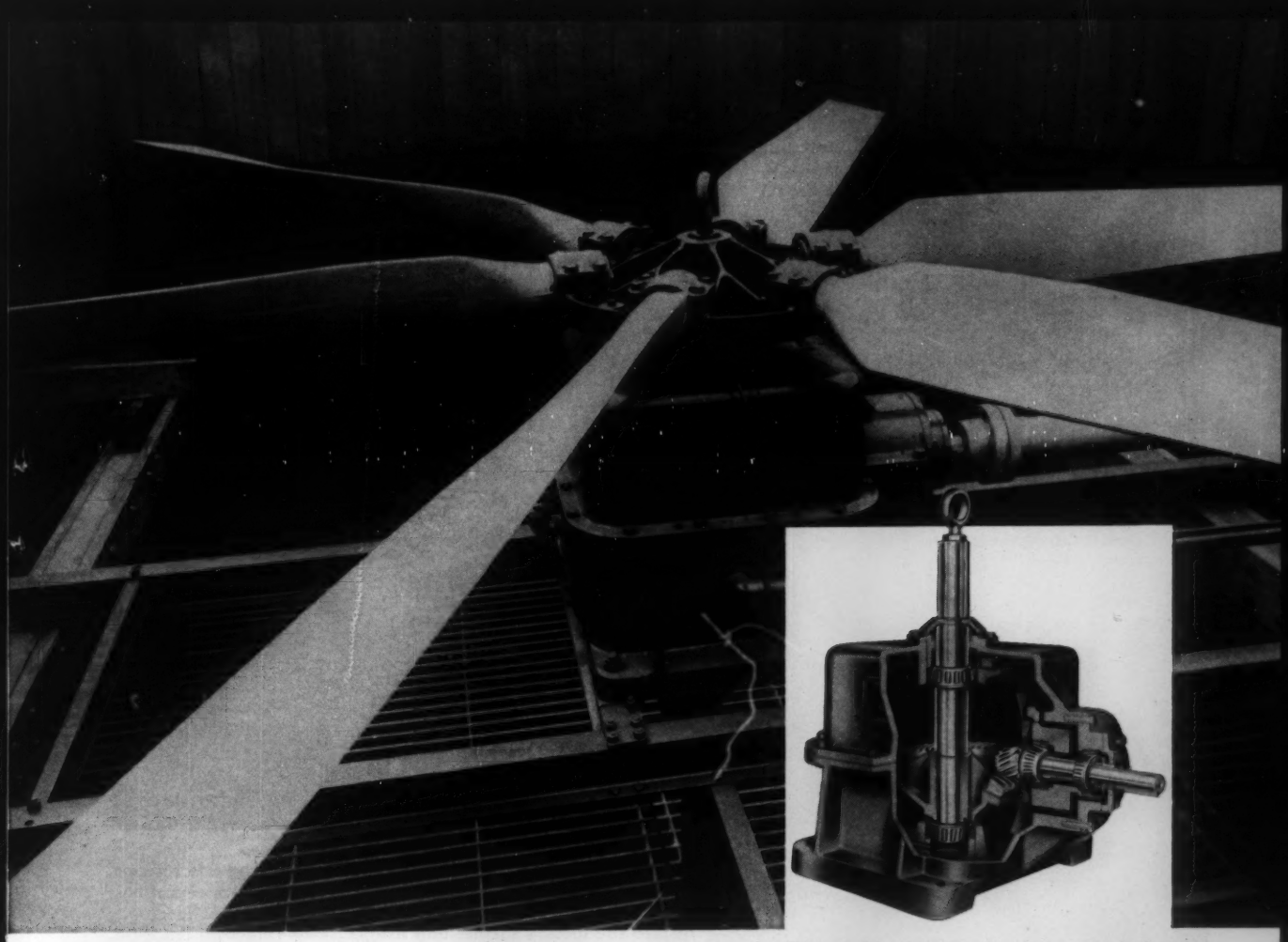
Some sweet new nylon plastics are made from a sugar-base compound. Starting compound of the material is prepared by reacting sugar with ammonia and hydrogen under pressure. Celanese Corp. of America has synthesized 50 different nylons and developed processes for altering their physical characteristics. Strength is variable, water sensitivity can be controlled, and the new nylons can be made with melting points much higher than existing polyamides.

• • •

Moon-nik? Legal claim to the moon can't be made by any country for a long time, says Dr. Norman MacKenzie, president of the University of British Columbia and one of Canada's leading experts in international law. Dr. MacKenzie said that landing on the moon would not be sufficient claim, but that "possession and control" must be established.

• • •

American Society of Engineers has been proposed by Dr. Joseph W. Barker, president of the Engineers Joint Council. Dr. Barker feels that such a national organization, composed of numerous specialized divisions, could speak for the engineering profession on questions of legislation, education, engineering philosophy and policy.



This spiral bevel gear combination permits the flexibility required to meet rugged 24-hour service while providing an economical, self-contained unit which requires practically no maintenance.

How to obtain help when you design bevel gear assemblies

The men who designed the gear reducer for the cooling tower fan shown above were assisted in many ways by Gleason engineers.

Cooling tower fan operation is generally recognized to be one of the most severe tests to which a gear reducer can be subjected. These towers demand a gear system that can operate twenty-four hours a day, three hundred and sixty-five days a year if necessary.

The gear reducer is subject to heavy loads and lies in the path of moist, corrosive air streams.

The gear drives for these cooling tower fans are subject to heavy loads and lie directly in path of moist, corrosive air streams.

Here is what the customer and Gleason engineers developed.

A spiral bevel drive of 19 x 76 combination and 2.5 DP. With spiral bevel gears the tooth bearing is localized which assures smooth and quiet operation and permits some mounting deflections without concentrating the load dangerously near either end of the tooth.

The use of this gear design also allowed the flexibility required to fit the fan unit into the over-all design of the tower and to produce an economical, self-contained unit which requires little or no maintenance.

Next, our engineers produced and tested prototypes of the design which the customer in turn tested in the final product.

Our engineers can also help you select proper mountings for such gear assemblies and advise you on such details as lubrication.

If you would like to take advantage of this service, write us the next time you have a problem involving bevel or hypoid gear systems. Furnish data covering type of application, loads and speeds and prints of the mountings. We would be pleased to assist you in the selection of your gears.

Meanwhile, you may find these Gleason Technical Handbooks helpful in your work:

"20° Straight Bevel Gear System"
"Spiral Bevel Gear System"
"ZEROL Bevel Gear System"

GLEASON WORKS

Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.

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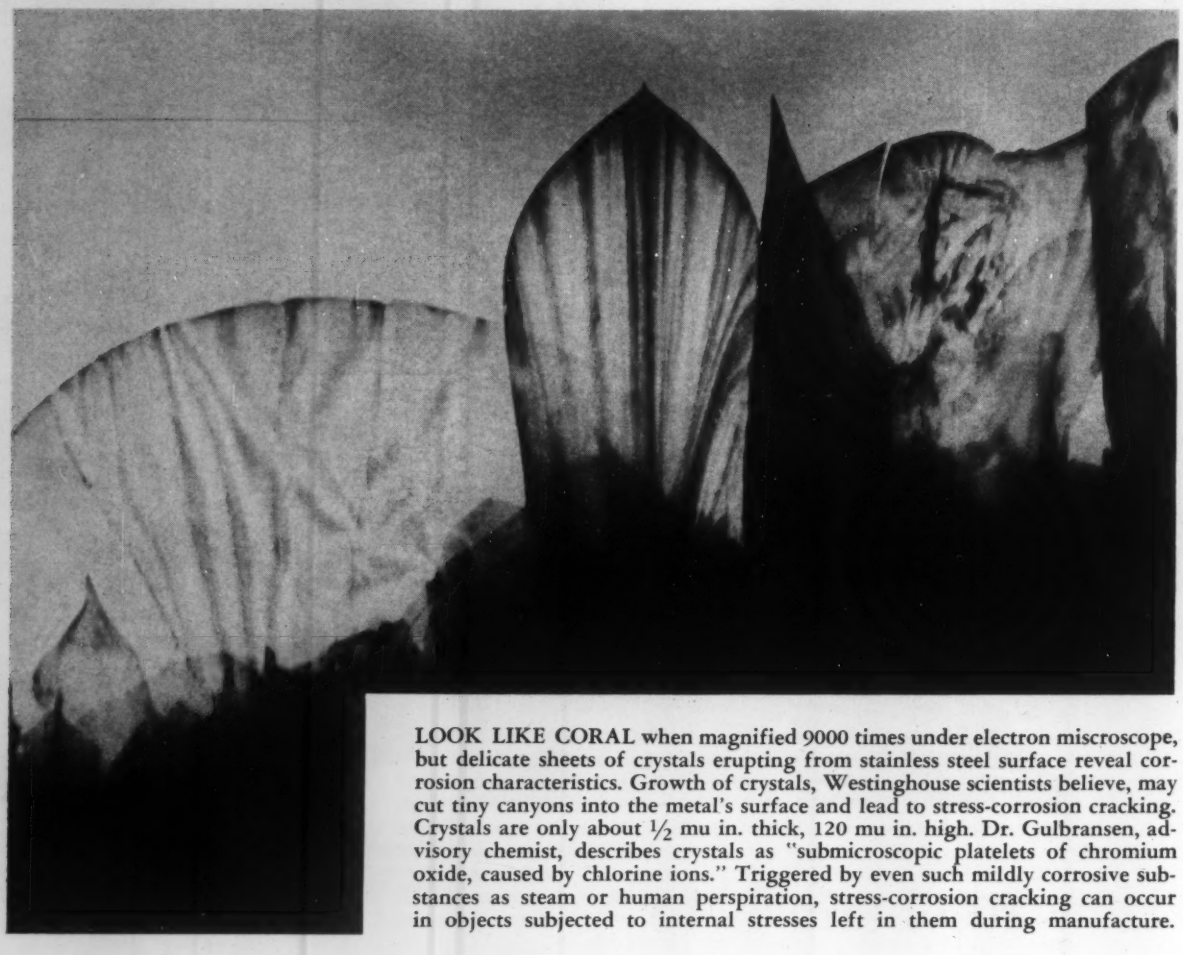
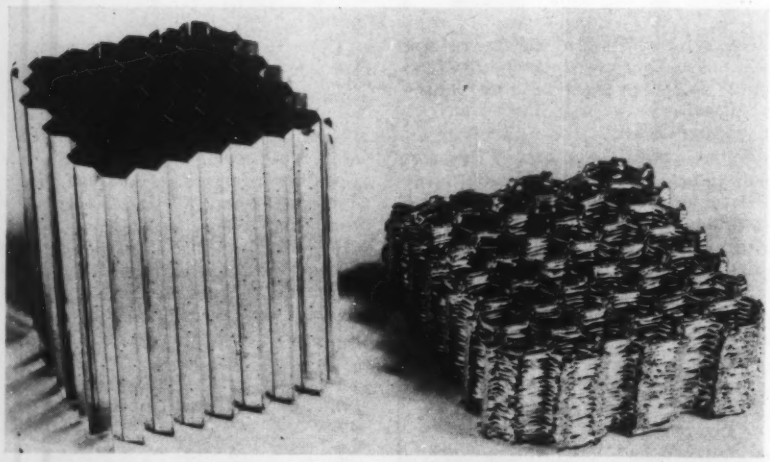


LOOK LIKE CORAL when magnified 9000 times under electron miscroscope, but delicate sheets of crystals erupting from stainless steel surface reveal corrosion characteristics. Growth of crystals, Westinghouse scientists believe, may cut tiny canyons into the metal's surface and lead to stress-corrosion cracking. Crystals are only about ½ mu in. thick, 120 mu in. high. Dr. Gulbransen, advisory chemist, describes crystals as "submicroscopic platelets of chromium oxide, caused by chlorine ions." Triggered by even such mildly corrosive substances as steam or human perspiration, stress-corrosion cracking can occur in objects subjected to internal stresses left in them during manufacture.

Safer Automobile Collisions Seen with Aluminum Padding

OAKLAND, CALIF. — Automotive safety and better industrial packaging are two uses suggested for new shock-absorbing material developed by Hexcel Products Inc. Made of aluminum honeycomb, the new material has been tested with favorable results by Hexcel and several defense agencies.

The ideal shock absorber presents a constant resistance during its total deformation, holding the deceleration force of the protected object constant, just below the damage level. Destructive impact forces are thereby reduced. Most padding materials deform in a nonlinear fashion; the more the deformation, the higher the resist-



Accordion-style collapse of aluminum honeycomb core, which accounts for its unique impact-absorbing qualities, is illustrated by these before-and-after samples. The accordion folds in the cell sides occur progressively starting at one face as the core collapses at a nearly constant rate.

ND FACTS

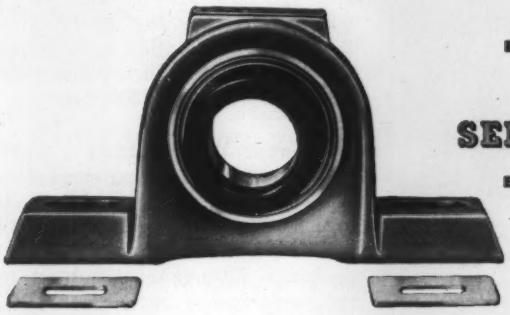
NEW DEPARTURE PILLOW BLOCKS— BUILT FOR LOWEST MAINTENANCE

- New Departure adapter ball bearings are sealed and lubricated for life.
- Design is compact and rigid—fits easily in limited space.
- No grease nipples or other protruding lubricating fixtures needed.
- Pillow blocks are easily mounted without need for any special tools.
- New Departure ball bearings are high capacity, precision-built for long life.
- Bearing and block surfaces are spherical to accommodate any misalignment.
- Thirty-two shaft sizes, $\frac{1}{2}$" through $2\frac{15}{16}$", for wide variety of applications.
- Interchangeable with most other makes of pillow blocks.

Bearings are easily applied to shafting and are positively locked in position with eccentric cam locking collar and set screw.

Elongated bolt holes designed to accommodate practically every type of spacing for hold-down bolts.

Mounting pads are furnished with each New Departure Pillow Block to assure easy interchangeability with all pillow blocks having a high base-to-center dimension.



EQUIPPED WITH

SENTRI-SEAL

BALL BEARINGS

New Departure Pillow Blocks employ performance-proved Type AE adapter ball bearing with Sentri-Seals for long-life protection against dirt or grease leakage.

Send for Catalog PBC

1908–1958 GM FORWARD FROM FIFTY

NEW DEPARTURE

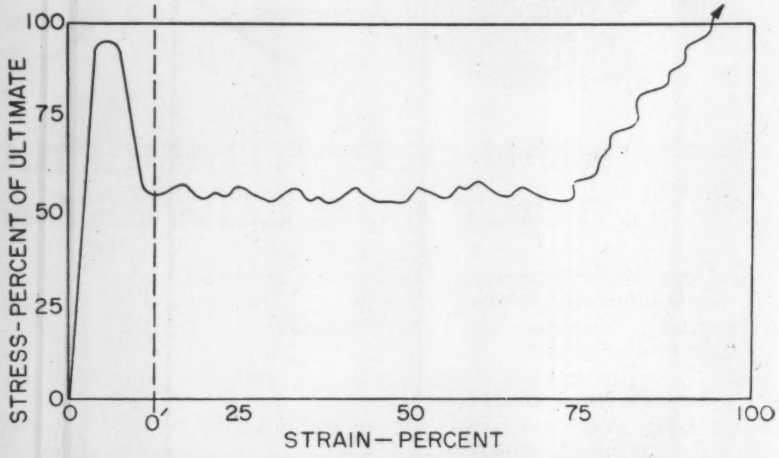
DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

ance to further deformation. The aluminum honeycomb structure is claimed to perform almost ideally. It collapses in accordian fashion, absorbing impact energy at a constant rate, as shown in the accompanying picture and graph.

Depth and area of the honeycomb buffer determines protection from damage. An automobile hitting a solid brick wall at 60 mph suffers extreme impact that may generate hundreds of g's. According to Hexcel, a honeycomb panel 18 in. thick and about 3 ft square would allow the car to stop in a foot instead of instantaneously, reducing impact damage to a more tolerable level of 30 g. Although this impact load is still too high for safety, it offers chance for survival. Doubling the depth and halving the area of the honeycomb would show even more dramatic reduction in damage.

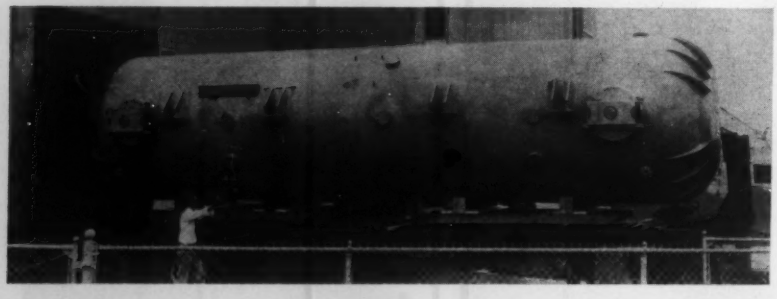
Hexcel suggests the use of strong, narrow honeycomb panels or a series of cylinders as an expendable shock absorber behind automobile bumpers. Thin panels could also be used beneath a suitable covering as dash board crash panels.



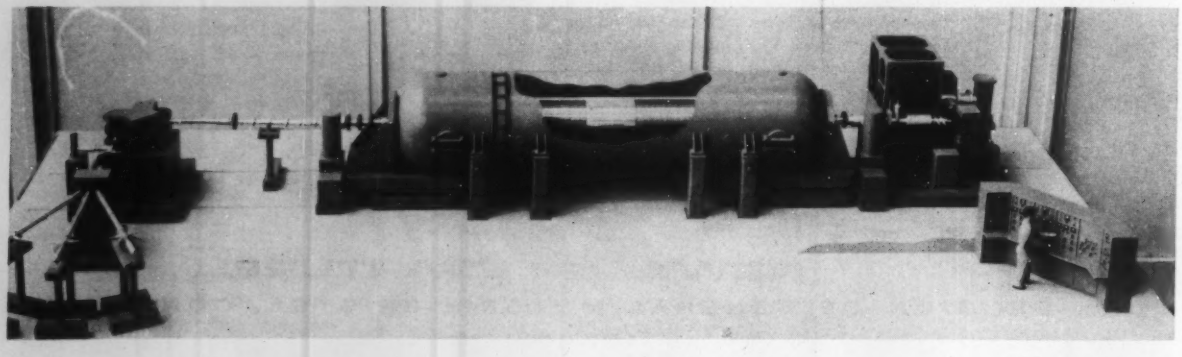
Dynamic measurement of honeycomb core collapse shows nearly constant stress-strain ratio after the initial strength of the core has been overcome. By slightly deforming the core material before impact the initial peak load is eliminated and the ordinate axis is displaced to zero, where the constant stress-strain relationship begins. Plastic in cells toughens the structure.

Densifying the honeycomb cells with foamed plastic further increases the stress-to-strain ratio and retains proper response. For example, aluminum with $\frac{1}{8}$-in. cells made up of 0.0015-in. wall thickness, has a crushing strength of 350 psi. Filled with plastic foam, the honeycomb has crushing strength of about 2500 psi.

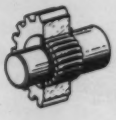
Much of the government work on the energy-absorbing characteristics of the new material has been in design of pallets for emergency air drops. Industrial crates and packages, although not subject to the same severe impact, may frequently warrant the protection provided by the honeycomb padding.



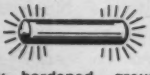
BEHEMOTH in Van de Graaf generator is this 34-ft long steel pressure vessel, 8 ft in diam, which covers the voltage-generating assembly of the unit. The tank is for the world's first 10 million v Tandem Accelerator, now in the assembly stage at High Voltage Engineering Corp. Tandems are being built for Atomic Energy of Canada Ltd., the University of Wisconsin, and Florida State University; intended for basic physics research.



Full complement of small diameter rollers insures maximum number of contact lines in load zone for high radial capacity in minimum space.

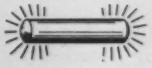


Mounted without races between hardened shaft and hardened housing (RC-60 recommended), Torrington Needle Rollers allow largest possible shaft diameters.



Carefully hardened, ground and lapped high carbon chrome steel makes each Torrington Needle Roller a precision part for long life performance.

Close tolerances are assured by stringent quality controls. Standard OD tolerance is .0002", but Torrington Needle Rollers can be supplied with tolerance of .00005". Tolerance on length depends on end shape.



Fine finish reduces friction to a minimum. Torrington Needle Rollers are usually polished to 4-6 rms, but finishes as fine as 1-3 are available on special order.

Now you can get highest capacity at lowest cost with Torrington Needle Rollers

A hardened shaft, a hardened housing, and precision Torrington Needle Rollers provide the most economical, highest capacity antifriction assembly you can obtain.

Six roller end shapes permit design flexibility whether the requirement be maximum effective roller length, proper fillet clearances or greater lip retainment. Torrington Needle Rollers are available in a complete line meeting SAE and AFBMA specifications. Torrington standards for material, heat treat, tolerance and finish of Needle Rollers are the highest in the industry.

Operating results with Needle Rollers depend on careful design of mating parts. Torrington's Engineering Department, with extensive experience in Needle Roller application, will be glad to give you technical advice on your needs. *The Torrington Company*, Torrington, Conn.—and South Bend 21, Ind.

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

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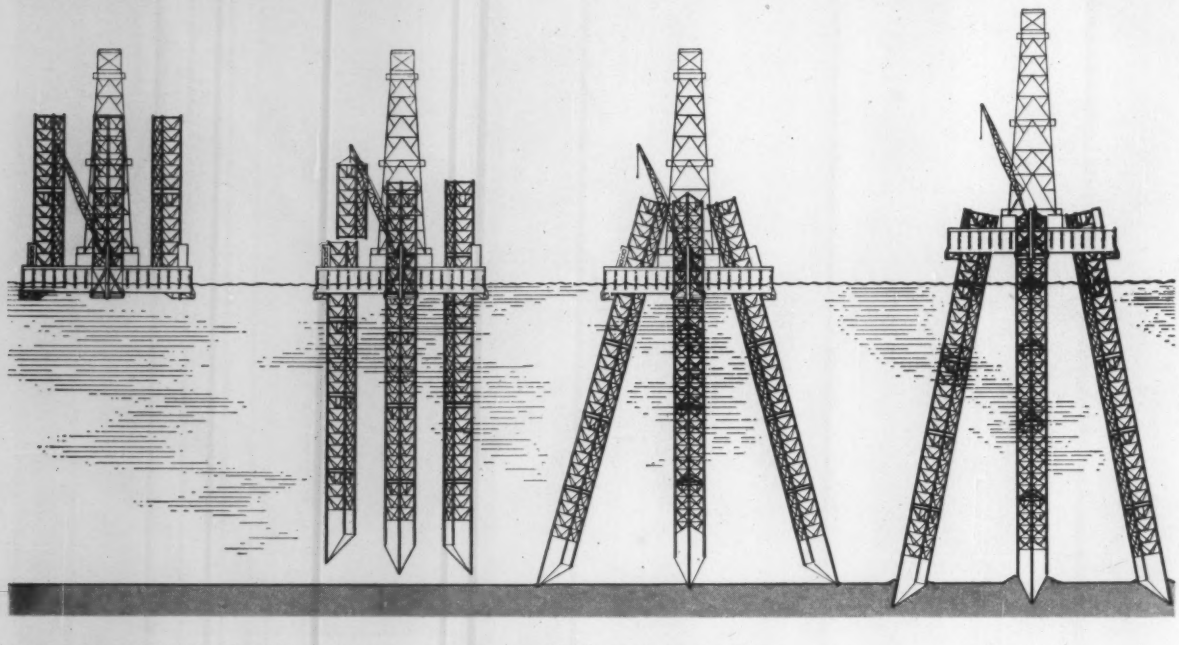
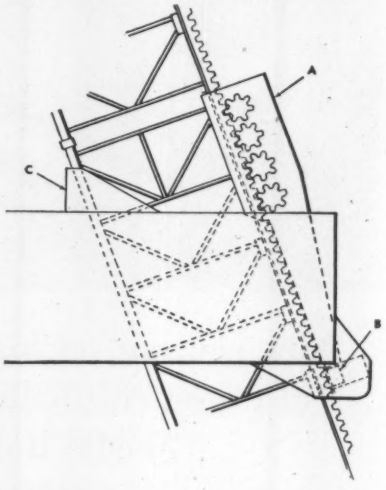


MARINE WILDCATTING in depths ranging to 600 ft may be possible with rigs similar to this self-erecting, self-elevating barge-platform. Four stages of positioning, above, transform the barge into a fixed platform 50 ft above water. Elevating mechanism, *A*, consists of electric gear motors coupled to a rack and pinion arrangement. This mechanism is hinged to the barge at *B* to permit independent or simultaneous operation at each spud. Barge guides are indicated at *C*. A similar elevating system on a 100-ft installation—deepest currently in use—uses 27 gearmotors to lift an 8 million lb platform. R. G. LeTourneau Inc. designed this deep-water system.



Nuclear-Powered Aircraft Seen Practical in Near Future

LOS ANGELES, CALIF. — Nuclear powered transport planes can be successfully designed to carry a "logistical payload"—50 tons or more—for a distance of over 24,000 miles, according to two Lockheed Aircraft Corp. scientists. Studies of nuclear-powered aircraft at Lockheed were disclosed recently by Robert W. Middlewood and Robert B. Ormsby in a paper presented before SAE's National Aeronautical meeting in Los Angeles.

Design features of the new plane would include easy loadability, ability to utilize existing airfields, capability of carrying all types of cargo, no requirement for extensive ground-handling facilities, and no need for large crews.

The new transport aircraft will most likely be a propjet, the engineers declared. This prediction is based on the fact that a given amount of energy released from a reactor, if utilized in a propjet engine, will produce over three times as much thrust for takeoff as it will in a turbojet engine. Lockheed's Hercules transports, already in Air Force operational service, have demonstrated the exceptionally short takeoff and landing capabilities of propjet power.

One reactor will probably be used as the basic power source, although planning includes a possible two-reactor plane. Divided shielding will be used as a means of reducing weight. In this manner some of the shielding will be around the reactor with other shielding around the crew compartment or other radiation-sensitive areas. Design and weight of shielding has been one of the chief problems in development of nuclear aircraft.

Scientist for President Predicted by Industrialist

Engineers Will Set Social Trends In Technical Generations Ahead

CHICAGO — Members of the engineering profession must assume responsibilities as the dominant "taste makers" of American society during the electronic-atomic era ahead, according to Motorola president Robert W. Galvin. Speaking before an opening session of

the AIEE, Mr. Galvin predicted that the U. S. would have a man of science as its president in generations ahead. He described science as a common language of the world and consequently a means of resolving many of the world's problems.

In the era ahead, Mr. Galvin said, a main concern will be with the problems posed by the prospect of superabundance in material things and the possibility of neglect in certain cultural and human values. A decisive factor will be the attitude and the example of the scientist.

Historically, in each era of the nation's history the dominant human force in the economy has had much to do with the shaping of political institutions and social customs. He cited the pioneer businessman and the farmer of colonial days, the industrial empire builders of the mid-19th Century, and the "group spokesman" of the 20th Century mass production era.

The balance of this Century, Mr. Galvin said, will see the attainment of such electronic-atomic maturity that scientific miracles will be commonplace.

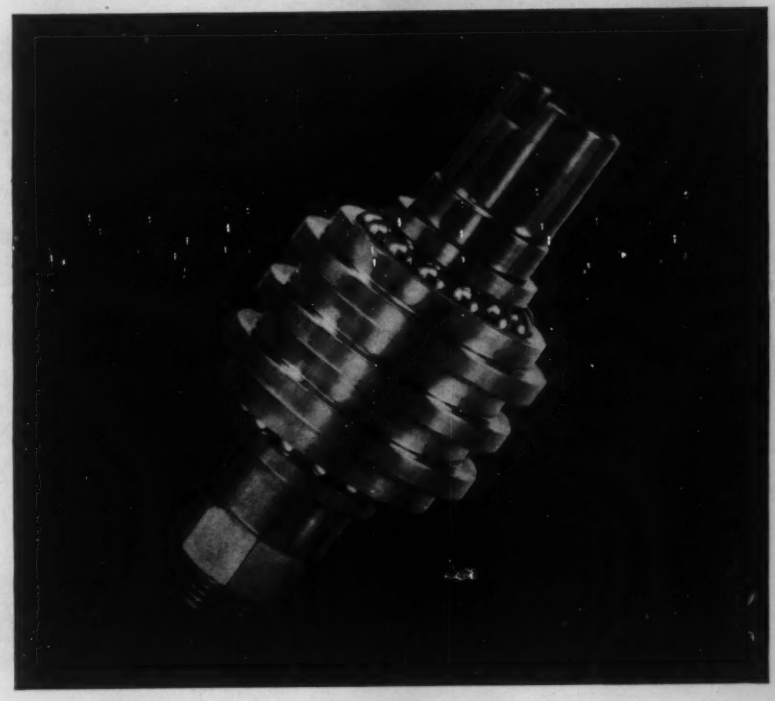
Engineers should guard against becoming one-minded, and measuring all relationships and values with an inflexible scientific slide rule. Noting tendencies now in this direction, Mr. Galvin cited the clamor for applied engineering education at the expense of fundamental science studies, and the tendency to emphasize quick or easy vocational training without enough regard for the arts or humanities.

"Let us hope," Mr. Galvin said, "that there will always be talented engineers who can, during one day, be fascinated with the precise formal art of perfecting an audio amplification system, and can become equally engrossed that same evening with the informal, inexact science of romping with his children, or taking a flight of imagination with a good novel."

"The overriding need in a science-dominated era of superabundance," he said, "will be for balance in human relationships."

(*Please turn to Page* 22)

Dual-Purpose Ball Bearing Solves Tough Design Problem



Anti-friction bearings made for specific applications free the designer from the limitations imposed by "standard" bearings, and permit a better product at lower cost. These advantages are demonstrated by the bearing shown above, which is used in an atomic reactor control mechanism. Consider the following features:

- The outside diameter has a tooth form that engages a lead screw. This saves the space, weight and cost of separate parts that would otherwise be required, and avoids variations resulting from a "stack-up" of tolerances.
- The bearing runs in hot water under pressure, at 350°-500° F.; and the water is its only lubricant.
- It withstands the corrosive action of high-purity water at the required operating temperatures.
- Low torque is essential; and dependability throughout a long life is of vital importance.

We obtained the required characteristics through the use of special alloys, and through very close control of bearing geometry, dimensions, and surface finish.

In similar ways, we have helped improve the design and performance of hundreds of other military and industrial products. If *you* need special anti-friction bearings for *any* purpose, let's talk it over. ***Bulletin on request.***

INDUSTRIAL TECTONICS, Inc.

ITI

MANUFACTURERS OF PRECISION BALLS AND BEARINGS

3692 JACKSON RD., ANN ARBOR, MICH.

WESTERN DIVISION PLANT: COMPTON, CALIFORNIA

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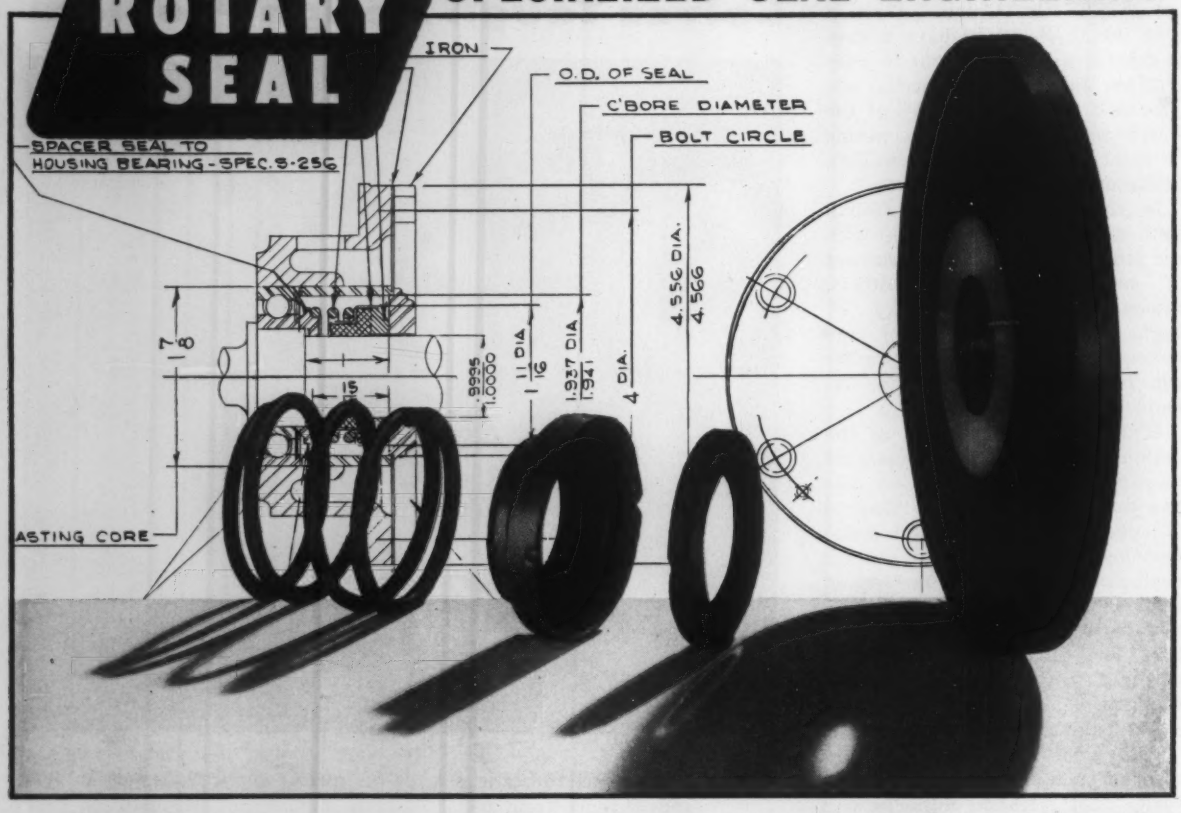
ROTARY SEAL

SPECIALIZED SEAL ENGINEERING



is developing new ways to assure top performance in AUTOMOBILE AIR CONDITIONING COMPRESSORS

Automobile air conditioning, a recent innovation, poses difficult new problems for the compressor maker. The Seal shown represents many months of designing effort, guided by years and years of specialized experience, to produce a Seal that's *right in every detail* — to assure steady unit performance uninterrupted by sealing difficulties.

This Seal, which has been developed for a leading manufacturer of compressors, well exemplifies the skill and patience of ROTARY SEAL engineering. That's our business — solving hard Shaft Sealing problems where production quantities of Seals are involved, by applying the basic ROTARY SEAL principles which opened the way to successful mechanical Shaft Sealing when this company introduced them years ago.

The best time to start solving your Shaft-Sealing problem is at the drawing-board stage. Call in our engineers for an early consultation—our experience with Seal applications of all kinds in many fields often indicates suggestions which can simplify design, lower costs and improve performance.

Shaft-Sealing with Certainty

ROTARY SEAL DIVISION
MUSKEGON PISTON RING CO., SPARTA, MICHIGAN

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EXTRAORDINARY BEARING PROBLEMS?

"REALI-SLIM" BALL BEARINGS

Ball radial — Angular contact — 4-pt. contact

Cross sections from ¼" to 1" and 4" to 40" bore diameters. Some sizes available from stock.

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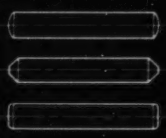
NEW!

Type KN

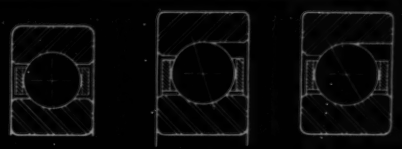
Standard sizes — in stock

NEEDLE ROLLERS



Spherical, conical or flat-end types

RADIAL BALL BEARINGS

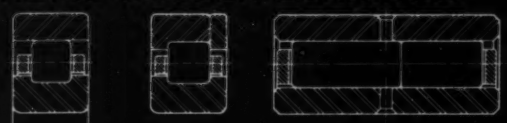


Conrad design, types LC, HC and BLC

Maximum capacity design, types HM, BLM

Angular contact design, types HA, BLA

RADIAL ROLLER BEARINGS

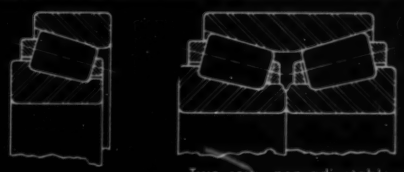


Lipped inner, straight outer race types RN, RX and RNW

Lipped inner, one lip outer, side ring type RP

Straight inner, straight outer, mill type RM

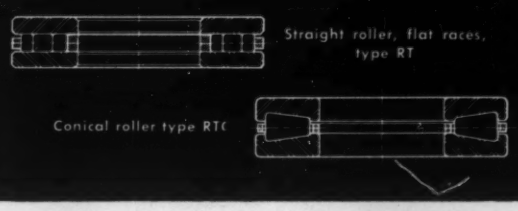
TAPER ROLLER BEARINGS



Single row type TS

Two row, non-adjustable type TNA

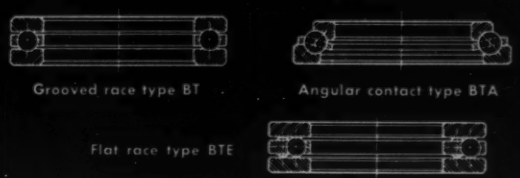
THRUST ROLLER BEARINGS



Straight roller, flat races, type RT

Conical roller type RTC

THRUST BALL BEARINGS



Grooved race type BT

Angular contact type BTA

Flat race type BTE

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When bearing problems seem next to impossible — when design considerations appear insurmountable — it's time to call KAYDON.

You'll find KAYDON'S full-time, experienced bearing-design engineers can take your problem in hand — and take worries off your mind. Their record is one of remarkable success — designing and producing bearings others said "couldn't be made."

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Rounding Up the 1958 Automobiles—3

LIKE other 1958 automobiles, the six models in this issue have more horsepower and more accessories and equipment than last year. Unitized construction is featured on one car, making a total of two U. S. manufacturers now using the process. The same manufacturers also utilize a body-dip method of painting, in which the body-frame unit is submerged in primer, for better protection against rust and salt corrosion.

All engines that are new for 1958 feature machined-in-block cylinders. Transmissions have been redesigned to take advantage of added power—resulting, in some cases, in larger brakes and additional safety features.

LINCOLN

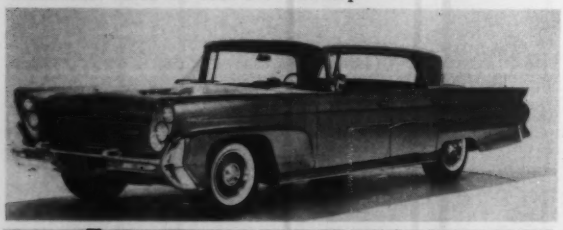
The Continental Mark III, available in four models, leads the Lincoln line for 1958. In addition to the familiar two-door hardtop, the new Continental series offers a four-door hardtop, four-door sedan, and the only convertible in the line. Premiere and Capri series are continued with three models each, styled similar to the Continental.

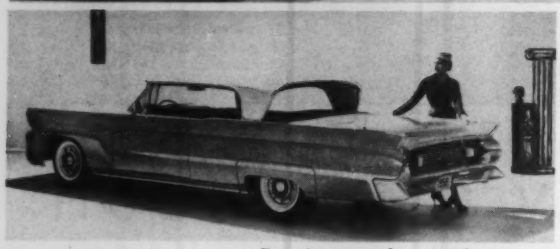
Major styling and engineering advances have been built around Lincoln's new, unitized body-frame construction. Wheelbase, at 131 in., is 5 in. longer than last year, and an overall length of 229 in. makes Lincoln the longest car on the road. Horsepower has been boosted to 375 hp with a new 430 cu in. engine. Good weight distribution and improved suspension system are said to give the car unusual handling qualities.

Canted dual headlights, matching lattice-type grilles in front and rear, and Lincoln's limited use of chrome decoration are styling highlights.

Custom features include a reverse-slanting, power-operated rear window on all Continentals, including the convertible. The soft convertible top and window retract into a hinged section of the long rear deck. Standard power assists include power brakes, windows, seats, and steering. A remote controlled outside rear-view mirror, five ash trays with lighters, and warning lights for fuel, oil, door locks, and lubrication are standard accessories.

Continental Mark III four-door hardtop





Premiere two-door hardtop coupe

Engine Specifications

Type	OHV, V-8
Bore & stroke (in.)	4.3 x 3.7
Displ. (cu in.)	430
Comp. ratio	10.5 to 1
Bhp, max	375 @ 4800
Torque, max (lb-ft)	490 @ 3100

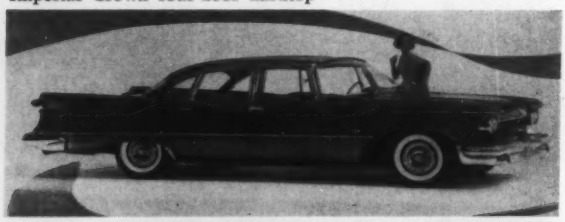
Size

Wheelbase (in.)	131
Length (in.)	229
Width (in.)	80.3
Height (in.)	56.5

IMPERIAL

Chrysler's luxury automobile, the Imperial, is available in four series with nine body styles for 1958. The Imperial series consists of a four-door sedan, and two and four-door hardtops. The Crown series adds a four-door sedan, two and four-door hardtops, and convertible. The remainder of the line is comprised of the LeBaron, a four-door sedan and new four-door hardtop.

Imperial Crown four-door hardtop



Imperial LeBaron four-door sedan

Slight styling changes include a redesigned grille, new front and rear bumper assembly, and larger

FASTER SPEEDS AND FEEDS ON 2 OPERATIONS
OVER ⅓ LONGER TOOL LIFE ON 3 OPERATIONS

AUTOMATICS

	A.I.S.I. 8620	Aristoloy 8620 Leaded
Spindle Speed R.P.M.	246	301
Feed I.P.R.	.0081	.0081
Machine Speed S.F.M.	120	150
Drill Speed S.F.M.	65	80
Minutes Per Piece	1.59	1.29

Tool Life Increased 35%

TURRET LATHES

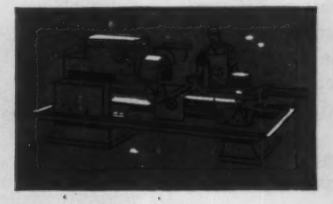
	A.I.S.I. 8620	Aristoloy 8620 Leaded
Spindle Speed R.P.M.	296	496
Feed I.P.R.	.021	.021
Machine Speed S.F.M. (drilling & boring)	85	118
Minutes Per Piece	2.31	1.91

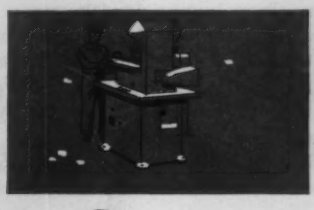
Tool Life Increased 35%

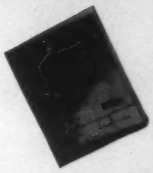
HOB MILLS (Threading)

Hob Speed S.F.M.	273*
Feed I.P.R.	11.8
Minutes Per Piece	1.84

*Maximum speed for machine. Changing to leaded Aristoloy brought about no improvement in machining time. However, tool life was increased 40%.







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Circle 415 on Page 19

"bubble" windshield. Overall length has increased about 2 in. to 225.8 in. Wheelbase, at 129 in., is unchanged. Horsepower rating is up from 325 to 345 hp.

Optional equipment includes the biggest tires ever offered on a production automobile—11 x 14; six ply —with recommended pressure of 17 lb in front, 14 lb in rear. "Auto Pilot" automatic throttle control and speed reminder is also optional. Other optional items include a nonslip differential, electric door locks which

Engine Specifications

Type	OHV, V-8
Bore & stroke (in.)	4.0 x 3.9
Displ. (cu in.)	392
Comp. ratio	10 to 1
Bhp, max	345 @ 4600
Torque, max (lb-ft)	450 @ 2800

Size

Wheelbase (in.)	129
Length (in.)	225.8
Width (in.)	81.2
Height (in.)	57

function electrically or mechanically, rear window defogger, and seat belts.

Six-way power seats and power windows are standard on the LeBaron, with Torque Flite transmission, power brakes, power steering, air foam seats and foam safety dash pad standard on all models.

CHRYSLER

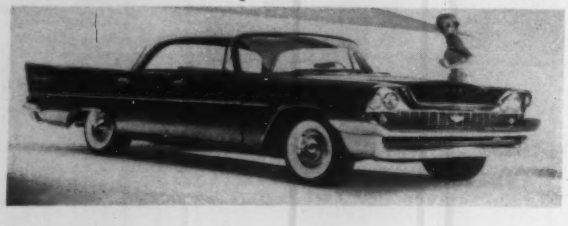
New nine-passenger station wagons added to the Windsor and New Yorker series expanded Chrysler's 1958 line to a total of 14 models.

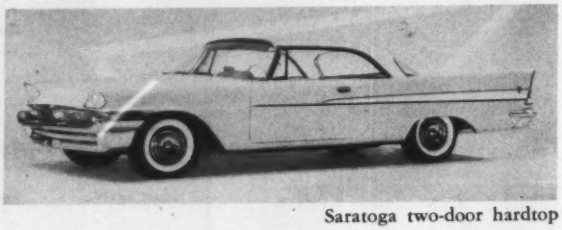
Styling refinements include a new 11-sq ft "control tower" windshield which curves into the roof line. An extra-large rear window, available on selected models, also curves into the roof and provides 40 per cent more rear visibility.

Higher compression ratios and improved carburetion have increased horsepower over the entire line. Top standard engine for the year produces 345 hp versus 325 hp for 1957. Engine innovations include a new four-barrel carburetor of simpler design and weighing 5 lb less than previous models. A new choke system improves fuel economy during warm-up periods and short-trip driving.

Equipment and accessories include a new pushbutton "auto pilot" which provides automatic throttle

Windsor four-door hardtop





Saratoga two-door hardtop

Engine Specifications

	Windsor, Saratoga	New Yorker, 300-D
Type	OHV, V-8	OHV, V-8
Bore & stroke (in.)	3.94 x 3.63	4.00 x 3.90
Displ. (cu in.)	354	392
Comp. ratio	10 to 1	10 to 1
Bhp, max	290 @ 4600 310 @ 4600*	345 @ 4600 380 @ 5200†
Torque, max (lb-ft)	385 @ 2000 405 @ 3200	435 @ 3600

*Saratoga series, with four-barrel carburetor.
†300-D series, with two four-barrel carburetors.

Size

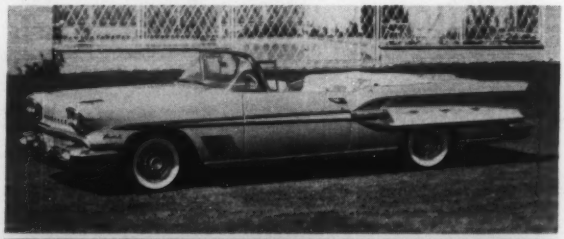
	Windsor	Saratoga, New Yorker
Wheelbase (in.)	122	126
Length (in.)	218.1	220.2
Width (in.)	79.6	79.6
Height (in.)	56.8	57

control for long-distance driving at sustained speeds. The device also acts as a speed reminder whenever a preselected speed is exceeded. Full-time power steering, optional on all models, has been redesigned for 1958. Front wheels turn from full left to full right in 3½ turns of the steering wheel.

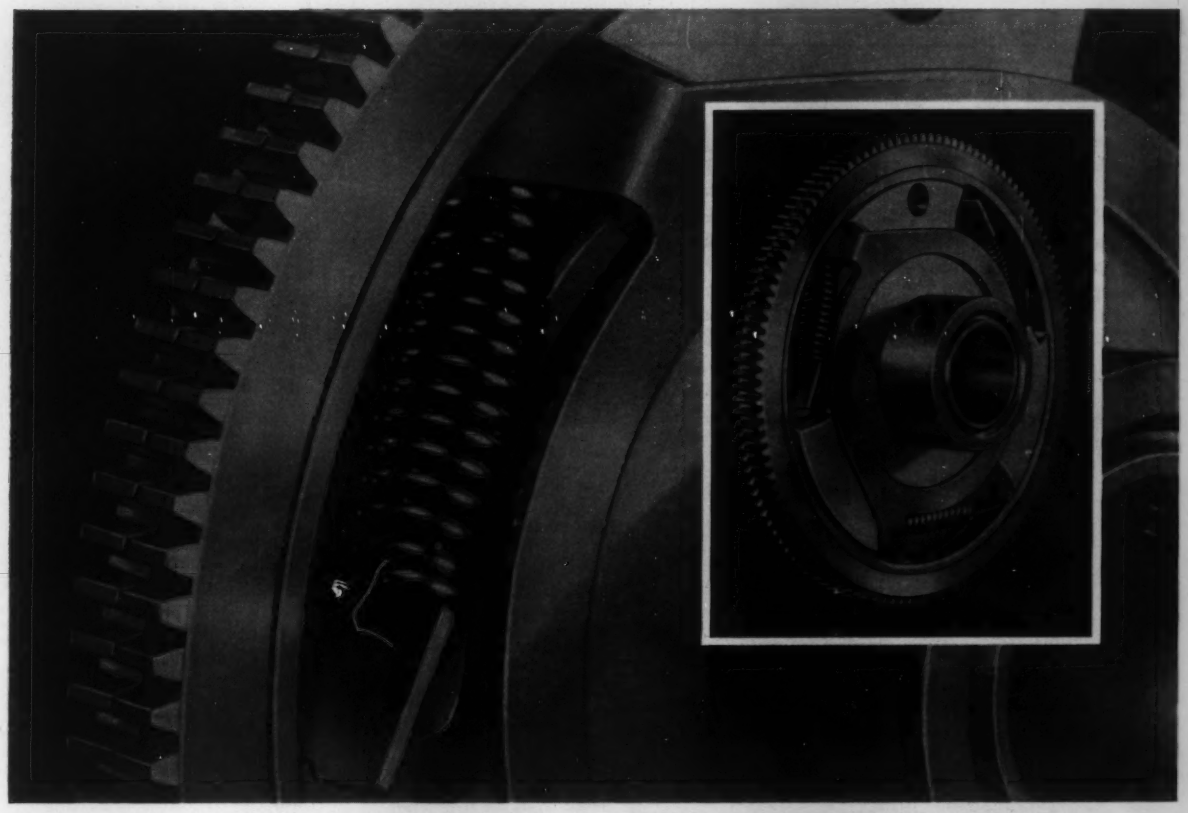
PONTIAC

The 1958 Pontiac is considerably restyled and emerges 3 in. lower, 2.2 in. wider, and 8.7 in. longer than comparative 1957 models. Wheelbase remains

Bonneville convertible



Super Chief four-door Catalina



G.S. gives you NON-SPREAD CONTROL for preloaded Gears with this patented "*SPRING-GRIP*" construction . . .

FRACTIONAL HORSEPOWER GEARING

GEAR Specialties, Inc.

2635 WEST MEDILL AVENUE
CHICAGO 47, ILLINOIS.

SPURS • SPIRALS • HELICALS • BEVELS • INTERNALS
WORM GEARING • RACKS • THREAD GRINDING

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARING

The cross-springing feature of this patented G.S. *"Spring-Grip"* construction holds the twin Gears of this anti-backlash unit under positive control—without spreading or parting—under thrust load from the mating Spur or Worm. Without such control, the scissors action which "pinches" the teeth of the mating part may be interfered with, through improper location of tooth contact with the mating part.

The illustration shows how this *"Spring-Grip"* feature is applied to a Worm Gear; one of the twin elements is fixed to the hub, the other is free to rotate within limits controlled by the springs. G.S. *"Spring-Grip"* construction is also available in straight or helical Spur Gears.

We can also supply other styles of preloaded Gears with compression-type coil springs, torsion or loop springs, to fit varying needs. All are made with the famous G.S. precision and rigid quality control, assuring the accurate tooth profiles so essential in the intimate contact occurring with anti-backlash Gearing.

G.S. specialized experience, broad line, and unsurpassed engineering and manufacturing resources—the most extensive in its field—can help solve *your* Fractional Horsepower Gear problems too. Call us in to discuss them!

SEND FOR *G.S. technical data, free! See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. Folder contains 23 pictures of Small Gears, plant view, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!*

41 Years of Specializing in Small Gearing!

unchanged. A new series of sports-styled cars heads the line of 14 models in four series.

The new Bonneville series, consisting of a custom convertible and two-door sport coupe, was designed for sports car performance with conventional-car comfort. It receives special treatment, including custom interior accessories, leather upholstery, optional bucket seats, and fuel injection. Standard Bonneville engine ranges from 285 to 310 hp, depending on carburetion. Engine displacement on all models has been increased with a corresponding increase in horsepower.

Contributing to Pontiac's lower silhouette is a new X-frame chassis and three-joint drive shaft. The resulting lowered center of gravity and new suspension, with coil springs added to the rear wheels,

Engine Specifications

	Synchromesh Transmission	Hydra-Matic Transmission
Type	OHV, V-8	OHV, V-8
Bore & stroke (in.)	4.06 x 3.56	4.06 x 3.56
Displ. (cu in.)	370	370
Comp. ratio	8.6 to 1	10 to 1*
Bhp, max	240 @ 4500 255 @ 4500	270 @ 4600 285 @ 4600
Torque, max (lb-ft)	354 @ 2600 360 @ 2600	388 @ 2800 395 @ 2800

*With fuel injection or three 2-barrel carburetors, comp. ratio is 10.5 to 1, bhp is 310 @ 4800.

Size

	Chieftain, Bonneville	Superchief, Star Chief
Wheelbase (in.)	122	124
Length (in.)	211.7	215.5
Width (in.)	77.4	77.4
Height (in.)	56.6	57

gives the car improved handling and riding qualities. Air suspension is optionally available.

New windshields and larger windows have increased visibility area up to 309 sq in. in some models. Suspended clutch and brake pedals are new, and optional this year is a nonslip differential.

DODGE

The new Dodge continues the styling pattern of last year, with a new "picture" windshield and redesigned grille altering the appearance for 1958. Dual headlights are standard on all cars. Nineteen models are available, including a series of six station wagons.

Greater displacement and higher compression ratio have increased horsepower of the top engine from 310 to 333 hp. Called the D-500, this engine is optional on all models and is equipped with two 4-barrel carburetors. Fuel economy is improved through a redesigned choke system.

Optional equipment includes a new power steering unit—smaller and more efficient than last year—and nonslip differential, new for 1958. Optional on two-seat station wagons is an under-the-floor luggage compartment.

Torsion-bar suspension, safety-rim 14-in. wheels,

Custom Royal four-door Lancer

Royal two-door Lancer

Engine Specifications

	Getaway 6	Red Ram V-8	Ram-fire V-8*
Type	In-line	OHV, Vee	OHV, Vee
No. cyls.	6	8	8
Bore & stroke (in.)	3.25 x 4.63	3.68 x 3.80	4.06 x 3.38
Displ. (cu in.)	230	325	350
Comp. ratio	8 to 1	9 to 1	10 to 1
Bhp, max	138 @ 4000	252 @ 4400	295 @ 4600
Torque, max (lb-ft)	208 @ 1600	345 @ 2400	385 @ 2800

*Available optionally in D-500 engine package with 361 cu in. displ., 4.12-in. bore. Bhp ranges from 305 @ 4600 to 333 @ 4800, depending on carburetion.

Size

	Four-door sedans	Two-door hardtops
Wheelbase (in.)	122	122
Length (in.)	213.8	213.8
Width (in.)	78.2	78.2
Height (in., loaded)	56.8	54.3

and Power-Flite transmission are retained from last year.

FORD

Ford features a major styling change and two new engines for 1958. Twenty-one models in five series are available, including six station wagons.

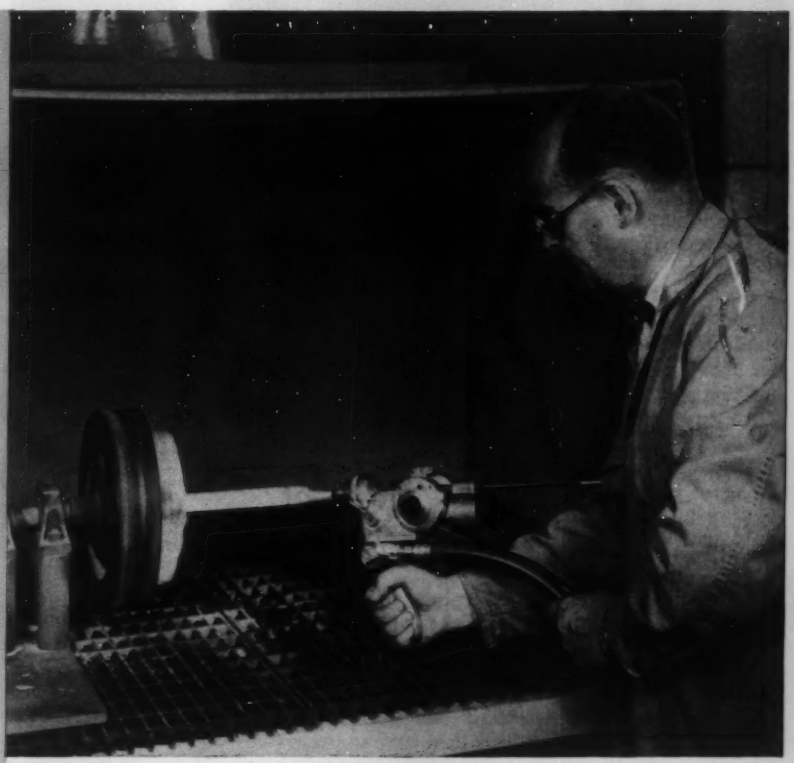
Front appearance is changed by dual headlights, a big wrap-around front bumper and new anodized aluminum grille. Hood treatment resembles the '57 Thunderbird. The roof gets a new look with seven front-to-rear grooves. Twin oval tail lights and a

Fairlane 500 convertible

ROKIDE* Spray Coatings Protect the Widest Variety of Parts

Some of many possible applications

BAFFLE PLATES
BEARING SURFACES
CRUCIBLES
METAL ROLLS
FEED ROLLS
NOZZLES
PUMP SHAFTS
GAS TURBINE PARTS
DUCT LININGS
EXHAUST PORTS
THERMOCOUPLE TUBES
THERMOCOUPLE WIRE
GENERAL WIRE
MECHANICAL SEALS



Applying ROKIDE Coating to pump shaft.

The three types of ROKIDE spray coatings — "A" aluminum oxide, "ZS" zirconium silicate and "Z" zirconium oxide — are hard, adherent, crystalline refractory materials. They can be applied to underlying parts, particularly metals, of a wide variety of shapes and sizes.

Parts on which ROKIDE spray coatings are especially useful are those requiring thermal or electrical insulation . . . refractoriness . . . resistance to wear or corrosion . . . high melting points . . . excellent mechanical strength . . . dimensional stability . . . relative chemical inertness.

The coatings are proving their great protective values in a rapidly growing number of applications. Included are not only the newer fields, such as the manufacture of missiles, ram jets, nuclear reactors, etc. Industry in general, including foundries, metal melting, heat and power plants — plus makers of automotive engines, electrical and electronic products, heavy and light chemicals, ceramics, and pumps — are also safeguarding many different parts with these new Norton developments.

Facilities for applying ROKIDE coatings are maintained at Norton Company, Worcester, Mass., and at its plant 2555 Lafayette Street, Santa Clara, California.

For the latest ROKIDE Bulletin, write to NORTON COMPANY, 770 New Bond St., Worcester, Massachusetts.

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BEHR-MANNING DIVISION
Coated Abrasives • Sharpening Stones
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Circle 417 on Page 19

Fairlane 500 four-door hardtop

V-sculptured trunk lid distinguish the rear view.

Ford's new engines feature machined, wedge-type combustion chambers, and show a substantial gain in horsepower over last year. Heading the line is the 352 cu-in engine rated at 300 hp. Biggest engine last year supplied 245 hp.

A new optional transmission, called Cruise-O-Matic, is designed for use with the higher performance engines. It has three drive ranges and retains the placement of reverse next to neutral on the selector quadrant, permitting reverse gear to be engaged without moving the selector through any forward speed position.

Air suspension and nonslip differential are available for the first time as optional equipment. Other optional items include two models of transistorized radios, two air conditioning units, and two types of heaters.

Engine Specifications

	223 Cu. In.	292 Cu In.
Type	In-line, 6	OHV, V-8
Bore & stroke (in.)	3.62 x 3.60	3.75 x 3.30
Displ. (cu in.)	223	292
Comp. ratio	8.6 to 1	9.1 to 1
Bhp, max	145 @ 4200	205 @ 4500
Torque, max (lb-ft)	212 @ 2100	295 @ 2400

	332 Cu In.	352 Cu In.
Type	OHV, V-8	OHV, V-8
Bore & stroke (in.)	4.00 x 3.30	4.00 x 3.50
Displ. (cu in.)	332	352
Comp. ratio	9.5 to 1	10.2 to 1
Bhp, max	240 @ 4600*	300 @ 4600
Torque, max (lb-ft)	340 @ 2400	395 @ 2800

*265 @ 4600 with optional 4-barrel carburetor.

Size

	Fairlane Series	Custom Series	Station Wagons
Wheelbase (in.)	118	116	116
Length (in.)	207	202	202.7
Width (in.)	78	78	78
Height (in.)	56.2	57.1	58.6

Pay, Advancement Poor, Government Engineers Complain

But Technical People Happy With Job Conditions, Benefits

NEW YORK—The government gives engineers and scientists a better deal than industry on working conditions, certain fringe benefits, and opportunity to publish. But industry is far ahead on pay practices, and professional and management environment.

These are the conclusions of over 17,000 government-employed scientists and engineers, according to a report by Albert F. Siepert, executive officer of the National Institutes of Health, at the Joint EJC-ECPD Assembly in New York.

Major dissatisfaction of government engineers centers around their prospects for salary advancement: Two-thirds of the government scientists and engineers feel that salary advancement is poor,

JOB SATISFACTION OF SCIENTISTS AND ENGINEERS IN GOVERNMENT AND INDUSTRY

Characteristics more likely associated with:

HIGH SATISFACTION	LOW SATISFACTION
Senior Grades (GS 14 or >$10,000)	Junior (Through GS 11 or $6,500)
Supervisors	Non-Supervisors
Advanced Degrees	College Degrees or less
Older Ages (over 45 years) ■	Younger Ages (under 30 years)
Middle Ages (31 to 45 years) ●	Middle Ages (31 to 45 years) ★
Research ■	Non-Research ■
Physical Scientists ★●	Physical Scientists ▲
Biological Scientists ▲	Engineers ★●

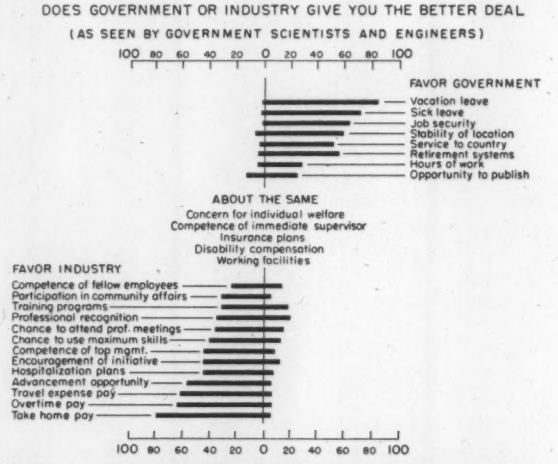
RESPONDENTS IN:

● Industry, ■ Total Government, ▲ Other Government (Non-Defense)

★ Defense, Both Government and Industry

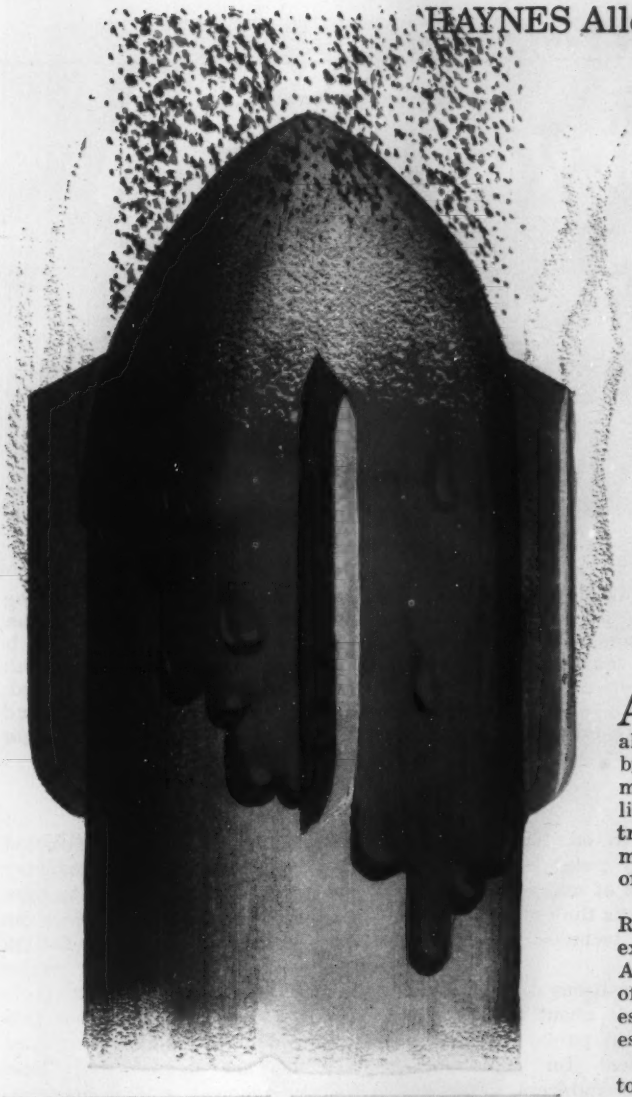
From White House Attitude Survey Data

How to pick a happy engineer or scientist. Survey of 20,000 government and industry technical people shows characteristics of the satisfied man in right column; unhappy man at left. Pay and seniority seem to have a big influence on job satisfaction.



Government engineers and scientists say they like their working conditions and fringe benefits better than they like industry's. But industry is far ahead on pay, promotions, prestige, and maximum use of talents.

HAYNES Alloys solve the *tough* wear problems

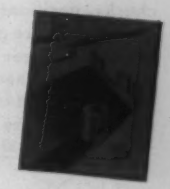


HANDLES 130 TONS of hot abrasive mixture without appreciable wear

A custom-tailored "Nose" made of HAYNES STELLITE alloy increased the service life of an extrusion torpedo by more than 10 times. The torpedo heats an abrasive mixture of thermoplastic resins containing finely ground limestone and red slate to about 400 deg. F as it is extruded under an 8000-psi pressure. The hot, abrasive material flows over the nose of the torpedo at the rate of 1.5 in. per second.

At one time an alloy steel torpedo, heat-treated to Rockwell C-35, was used in this application. It suffered extreme wear after handling only 13 tons of the mixture. A tool steel nose gave no better service. The nose made of HAYNES STELLITE alloy showed no wear after processing 45 tons of material, and is still in use after processing over 130 tons.

There are over 20 HAYNES alloys specifically designed to resist heat, corrosion, abrasion, or erosion, that can be shaped to your specifications and furnished ready to use. For literature, write to HAYNES STELLITE COMPANY, Division of Union Carbide Corporation, Kokomo, Indiana. For on-the-job assistance, contact one of our district offices located in Chicago, Cleveland, Detroit, Houston, Los Angeles, New York and San Francisco.



The original torpedo, constructed of conventional materials, is well-worn after handling only 13 tons of the abrasive mixture.

Ten times the life and still no sign of wear is the record made by the HAYNES STELLITE alloy No. 3 part, shown above.

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation

Kokomo, Indiana

UNION CARBIDE

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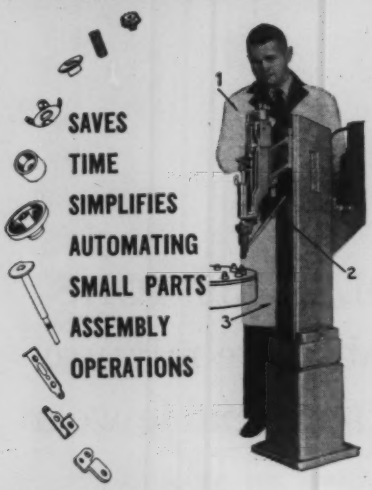
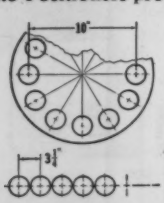
New Standard DIXON Auto-Positioner



AUTOMATICALLY GUIDES PARTS OF 1/4" TO 3" O.D. SIZE AT RATES UP TO 6,000 PER HOUR

The new Dixon Auto-Positioner combines three standardized units—(1) Automatic Air-Operated Positioner, (2) Automatic Escapement, (3) Mounting Structure. Because the unit is compact and fits into small space, it provides an economical solution for a wide range of small parts assembly. It has an exclusive sensing feature that automatically stops your machines when parts are missing or malformed. Auto-Positioners are easily arranged at single or multiple stations with feeders, feed tracks, transfer or indexing tables. With properly tooled chucks, positioning punch, and proven feeder, parts are positioned at rates up to 6,000 pieces per hour. Individual units or any combination of standard components available from stock. Tooled Auto-Positioners provided to suit needs.

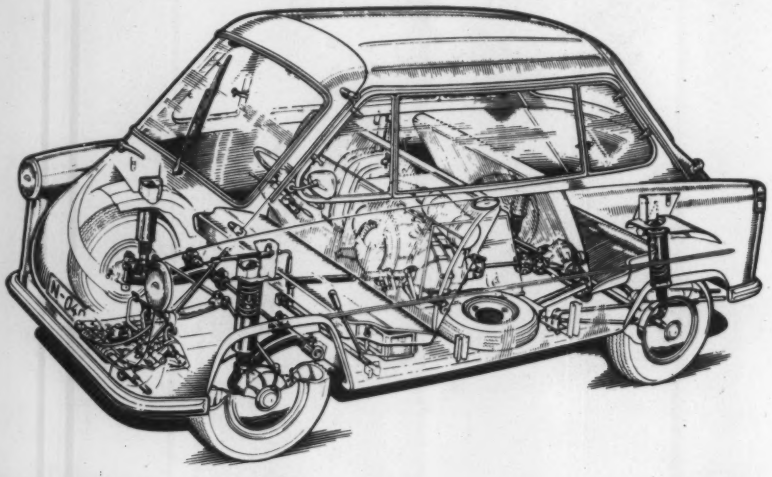


May be located at adjacent stations, only 3¼" apart for straight-line indexing, or on 12-station dial with a 5" fixture radius.

WRITE FOR FREE DATA SHEETS
New bulletins supply specifications and application data on standardized units now available from stock.

DIXON AUTOMATIC TOOL, Inc.
2310–23 rd AVENUE
ROCKFORD, ILLINOIS
Equipment for Automatic Parts Handling and Assembly

Circle 419 on Page 19



CENTER-MOUNTED ENGINE, torsion-bar suspension, and rear-facing back seat are unusual features of the four-passenger, German-built Janus. The one-cylinder, two-cycle engine rates 16 hp at 5000 rpm. Top speed is 60 mph; fuel consumption is 55 mpg. Body is monocoupe construction with full-width doors at front and rear. Hydraulic brakes are forced-air cooled; hydraulic shock absorbers can be adjusted for varying loads. Engine and differential are rubber suspended. Length is 110 in., height 55 in., weight 880 lb. Berliner Automotive Corp. is U. S. distributor.

in contrast to one-fourth of the 3300 industry people surveyed. In no other area of major importance in the survey is the unhappiness of government technical people so strong.

Some reservations or feelings of embarrassment about their choice of a career in public service are clearly evident for government scientists and engineers. They are less willing than engineers and scientists in industry to recommend employment in their agency to outside professional colleagues or, perhaps a tougher test, to a friend's son trained in their field. Even less certain is their feeling that their own employment is favorably regarded by their outside professional colleagues.

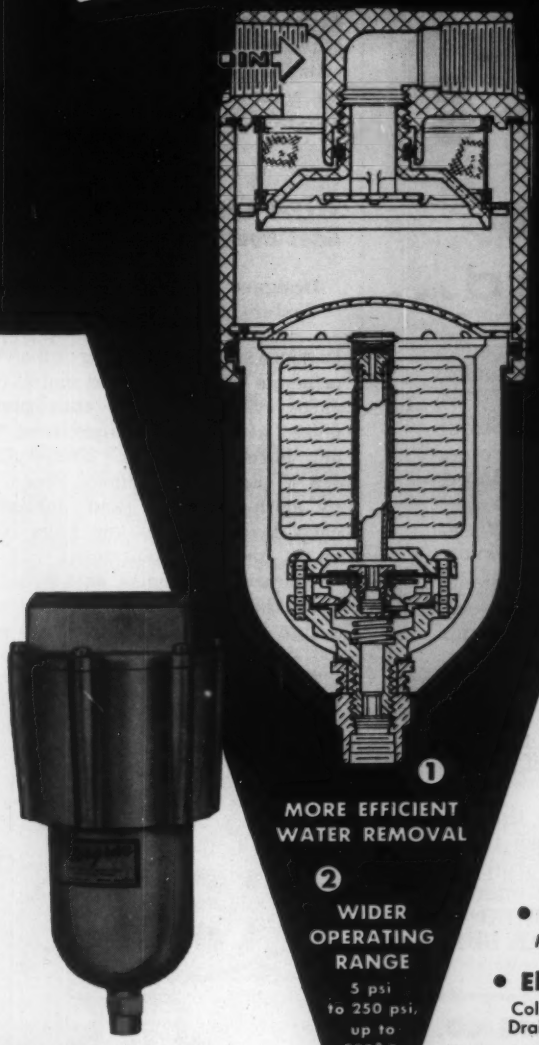
For both government and industry, the survey was able to separate out the characteristics of men most likely to be satisfied or dissatisfied with their jobs. For instance, senior grades were more likely to be satisfied than junior grades, and supervisors more satisfied than nonsupervisors. Engineers in both industry and defense work tend to fall into the less-satisfied group.

People who are well satisfied with their jobs, both in industry and government, are likely to have a completely different outlook on their jobs from low-satisfaction groups. The two items or major difference are management problems: "Does your supervisor talk with you often enough about how well you are doing?" and "Does top management in your organization really appreciate what you do?" The amount of freedom to formulate and develop their own research ideas seems to make a big difference between satisfaction and dissatisfaction among research people. Large differences also show up in satisfaction with career prospects and the reputation of the employer.

Detailed information on the results of the survey is available in *Survey of Attitudes of Scientists and Engineers in Government and Industry*, available from U. S. Government Printing Office, Washington 25, D. C., at 50c per copy.

Process for bonding developed by the Martin Co. has earned that company the John Price Wetherill

NEW Advanced design Norgren AUTOMATIC-DRAIN AIR LINE FILTERS



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You Get These Important Advantages:

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  Greatly increased water removal efficiency—even at air flows 143% higher than ever before.
- **Operates Over Wider Pressure Range**
  Top efficiency at as low as 5 psi for all models and as high as 250 psi for metal bowl type.
- **Operates Over Wider Temperature Range**
  New metal bowl models in ¼", ⅜" and ½" sizes extend temperature range to 200° F.
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  Metal bowl models are ideal for applications likely to get rough usage.
- **Simplified Drain Mechanism**
  More efficient operation. Fewer parts.
- **Eliminates Manual Draining**
  Collected liquid is drained automatically—cannot return to air line. Drain operates as long as pressure is on the system.
- **Choice of Three Filter Elements**
  74, 64 or 25 micron elements—interchangeable.

NOW—24 Models to choose from

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A7-9381⅔

News Roundup

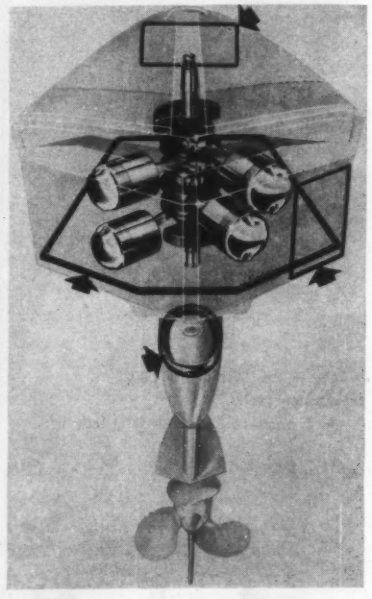
Medal of the Franklin Institute of the State of Pennsylvania. This award, usually made to an individual, will cite Martin's "intensive research, development and manufacture of bonded structures." The Martin bonded structure is a honeycomb made by joining corrugated metal foil to form hexagonal cells, then joining metal skins to the core, both with an adhesive developed for this purpose.

V-Type Engine Goes Boating

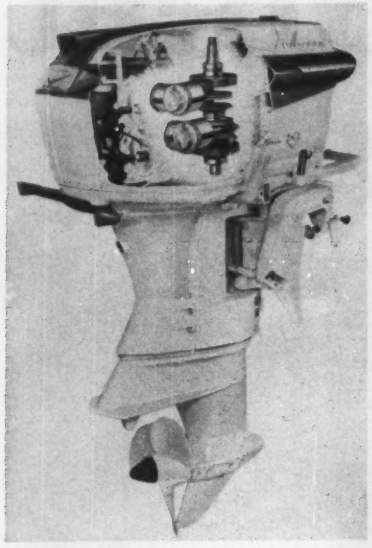
Designed Quiet to Impress Boaters, Shore Residents

CLEVELAND — Applying the V-principle to the outboard motor reduces vibration and consequent noise, also lends compactness in new outboard motors. Four-cylinder V-engines, announced recently by both Evinrude and Johnson, each develop 50 hp and have 70.7 cu in. piston displacement.

Vibration and noise, said to have been the missing link in modern design of outboard motors, are re-



In Evinrude's new four-cylinder V motor, soundproof chambers extend from hood to propeller. Arrows indicate rubber seals which are claimed to isolate sound completely.



Smoothness of operation in Johnson's new four-cylinder V motor was tested by placing a glass of water on the cover of an operating engine. Not a drop was spilled. Because boat transom was found to act as sounding board, a system of rubber mountings now isolates motor from the boat.

duced by balancing the inertial force of the pistons. In new 90-degree V-engines, these forces offset each other, creating less vibration. Crankshafts are shorter and stronger. Height of each engine is nearly half that of an in-line engine with the same number of cylinders. Both engines use twin-barrel, downdraft carburetors.

Each company offers electric or rope-starting versions of its V-4. Other features include special thermostatic control of cooling systems, tilt locks for trailing and for use on the water, and high-capacity fuel pumps.

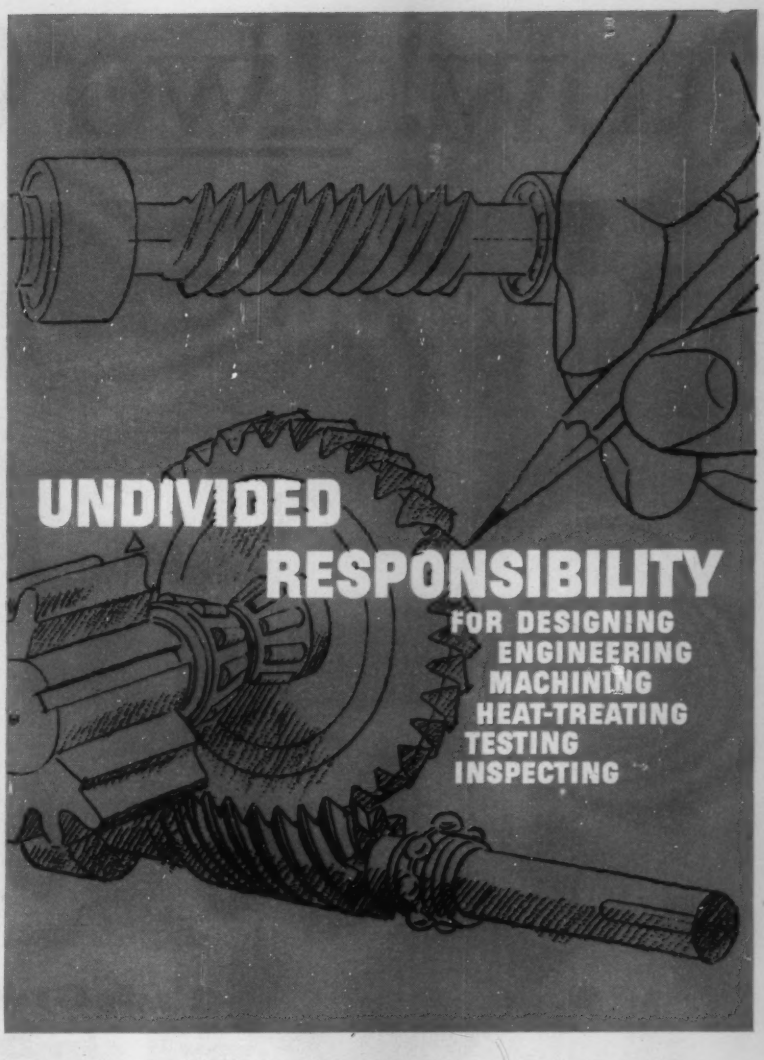
Meetings

AND EXPOSITIONS

Dec. 9-13—

Eastern Joint Computer Conference and Exhibit to be held at the Sheraton-Park Hotel, Washington,

(*Please turn to Page* 36)



• BRAD FOOTE Gears will perform satisfactorily when used in your shop —or on equipment you sell to others—because BRAD FOOTE can unconditionally guarantee their quality.

Every manufacturing step from the inception of the original design to delivery of the finished gears—including heat-treating—is completely controlled—here—in our own plant.

No one shares our responsibility.

BRAD FOOTE makes any type of gear—out of any type of material. BRAD FOOTE makes speed reducers, transmissions and intricate power units. All are famous for long, satisfactory service.

Why not discuss your requirements with our engineering staff, let us make recommendations or quote on your specifications. It can cost you much more to settle for less than BRAD FOOTE quality and service.

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Circle 422 on Page 19

Now! Two Great

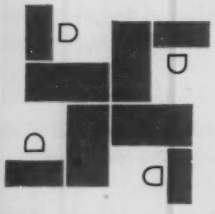
A Great "New-Look" in Drafting Tables!

Here is a dramatic new concept in drafting tables that brings *new reference convenience, new personalized working space, new smartness of surroundings* to modern engineers and draftsmen!

The unique "L" contour allows quick, comfortable movement between drawing board and reference desk. The desk-high, fully adjustable drawing board insures efficient, comfortable working positions. It can be adjusted to any angle from horizontal to vertical, has a 20″ vertical adjustment. It automatically locks at 35° from vertical until released manually. An angle sensing device provides complete counterbalancing action.

The versatility of the "L" contour table lends itself to efficient room layouts. The reference desk can be changed to right hand or left hand. The entire unit takes only 60″ x 71″ floor space.

Now, at last, you can give your engineers and draftsmen efficient, smart-looking, "private office" working areas—achieve a higher degree of morale—with an installation of new "L" contour tables. Take this opportunity to get full information by mailing the coupon at the right.



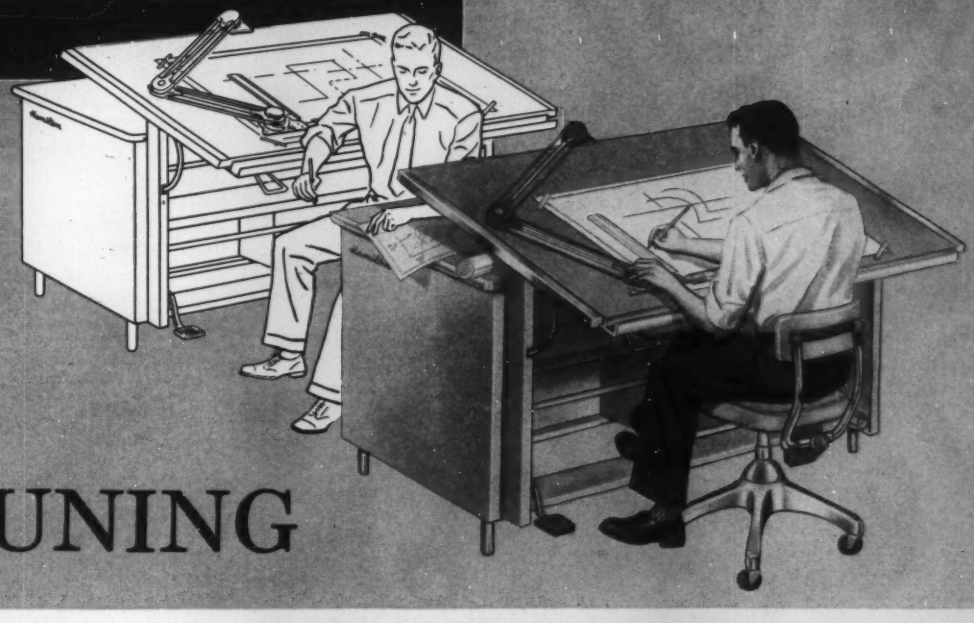
Here is one of the many arrangements you can make with versatile "L" contour tables to meet any specific requirement you might have.

Whether it's the newest in drafting room furniture or drawing pencils, you can get it from Bruning. There's a Bruning branch office near you. Why not make it your one convenient source for everything you need in drafting and reproduction?

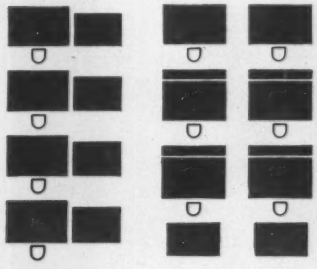
Drafting Tables!

NEW, IMPROVED HAMILTON

AUTO-SHIFT



BRUNING



Conventional Arrangement

Auto-Shift Arrangement

A Great Drafting Table— Made Even Better!

To thousands of drafting departments, Auto-Shift has meant *maximum* production in *minimum* of floor space. Now, new design and new features further increase the utility of Auto-Shift, bring new smartness and dignity to modern engineering and drafting departments.

New Auto-Shift comes in a new green color, complementary to any modern office decor. From the new chrome plated adjustable legs to the new green drawing surface; Auto-Shift is streamlined and handsome. Vertical and tilt controls are handily located at the left side but concealed from view. Many new conveniences include: roll tracing storage bin, full depth book case and upper shelf for extra storage, reference surface that extends 7½" and locks in position, exclusive mounting strip for linoleum cover.

New Auto-Shift is timely! With today's shortage of good draftsmen, Auto-Shift will help you hold your best men, help them do their best work. You owe it to yourself and your company to investigate by mailing the coupon below.

BRUNING

Ask your Bruning representative about the free Bruning-Hamilton drafting room planning service.

Charles Bruning Company, Inc., Dept. 114-K
4700 Montrose Ave., Chicago 41, Illinois
In Canada: 105 Church St., Toronto 1, Ont.

Please send me literature on the new Hamilton drafting tables.

Name _____ **Title** _____

Company _____

Address _____

City _____ **County** _____ **State** _____

Circle 423 on Page 19

● Major developments in recent years have resulted in new upper limits for gray iron castings. Modern metallurgy is providing irons in a wider range of mechanical and physical properties. Improved materials and new molding techniques are producing castings with a better surface finish and closer dimensional accuracy. Instrumentation and control in all phases of gray iron production are boosting quality. As a result of these accomplishments, modern gray iron castings are replacing other production materials—even so-called miracle metals—in countless applications heretofore considered impossible to cast in gray iron.

Free Summary of Specifications. *Be sure you are fully acquainted with the new "upper limits" of gray iron. Write for a copy of GIFS up-to-date "Summary of Specifications."*

it's time to design with

GRAY IRON CASTINGS

GRAY IRON FOUNDERS' SOCIETY, INC.
National City-East 6th Bldg. • Cleveland 14, Ohio

News Roundup

(*Continued from Page* 33)

D. C. Sponsors are Institute of Radio Engineers, Association for Computing Machinery, and American Institute of Electrical Engineers.

Jan. 6-8—

Fourth National Symposium on Reliability and Quality Control in Electronics to be held at Hotel Statler, Washington, D. C. Sponsors are American Institute of Electrical Engineers, Institute of Radio Engineers, American Society for Quality Control, and Radio-Electronics - Television Manufacturers Association. Additional information can be obtained from Mr. W. H. Rombach, Chief Quality Control Engineer, Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa.

Jan. 13-17—

Society of Automotive Engineers Inc. Annual Meeting and Engineering Display to be held at the Sheraton-Cadillac and Statler Hotels, Detroit. Further information is available from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Jan. 28-31—

Institute of the Aeronautical Sciences. 25th Annual Meeting to be held at the Sheraton-Astor Hotel, New York. Further information is available from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Feb. 2-7—

American Institute of Electrical Engineers. Winter General Meeting to be held at the Hotel Statler, New York. Additional information can be obtained from institute headquarters, 33 W. 39th St., New York 18, N. Y.

Feb. 4-6—

Society of the Plastics Industry Inc. 13th Annual Technical and Management Conference of the Reinforced Plastics Div. to be held at the Edgewater Beach Hotel, Chicago. More information is available from Society headquarters, 250 Park Ave., New York 17, N. Y.

Circle 424 on Page 19

Circle 425 on Page 19→

Miller®

4 New Hydraulic Cylinder Features Benefit You 9 Ways ...At No Added Cost

MORE MILLER "FIRSTS"

NEW! ALL TEFLON SEALED AGAINST EXTERNAL LEAKAGE...

1. Eliminates Seal Damage from Fluids—Teflon is Impervious to all Hydraulic Fluids (Including Fire-Resistant Types) . . . Hydraulic Cylinders with Teflon Piston Cups Slightly Higher.
2. Eliminates Seal Damage from High Temperatures—Teflon Sealed Cylinders Operate At —100° F. to 500° F.

NEW! ROD BUSHING SEAL . . .

1. Eliminates Shearing of "O" Ring in Re-Assembly
2. Eliminates Extrusion of "O" Ring at Extreme Pressures.

NEW! SHEF SEAL AT TUBING ENDS . . .

1. Eliminates Shearing of "O" Ring in Re-Assembly
2. Eliminates Extrusion of "O" Ring at Extreme Pressure—Teflon Sealing Ring is Backed by Zero Clearance Metal Shoulder.

NEW! LOCK-SEAL CUSHION ADJUSTMENT SCREW . . .

1. Eliminates Screw Projection Beyond Head and Cap — Cylinders Mount on Any Side.
2. Eliminates Manual Sealing and Locking After Flow Adjustment—Teflon Seal is Self Regulating and Self Locking.
3. Eliminates Accessibility Problems—Cushion Screw Interchangeable with Ball Check Position—Adjustable Through Small Wrench Hole Drilled in Interfering Machinery.

*du Pont trademark for its tetrafluoroethylene resin.

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Turn Page For Cross Section Of SHEF SEAL

SHEAR PROOF
HEAT PROOF
EXTRUSION PROOF
FLUID PROOF
Teflon Pressure Energized
SHEF SEAL
Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR

OTHER MILLER QUALITY FEATURES

- Case-Hardened Chrome Plated Piston Rod
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers
- Interchangeable Square Design

MILLER FLUID POWER

2006 N. Hawthorne Ave., Melrose Park, Ill.

HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

Miller

Announces a New Space and Price Saving Hydraulic Cylinder Line

SAVE UP TO 76% OF COST

Heavy Duty Model LH—Same Size As Ordinary Gasket Type Square Design Low Pressure Cylinders			
BORE	NORMAL RATINGS	NON-SHOCK INTERMITTENT RATINGS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
1½"	1500 PSI	2500 PSI	27%
2	1500	2500	27%
2½	1000	1500	28%
3¼	1500	2500	32%
4	1000	1500	35%
5	800	1200	37%
6	800	1200	43%
8	500	800	50%
10	500	800	71%
12	500	800	76%
14	500	800	*Not Available in 2000-3000 PSI*

MORE MILLER "FIRSTS"

Miller

Announces 50% More Power Per Cylinder Dollar

with Extra Heavy Duty

3000-5000 PSI MODEL H HYDRAULIC CYLINDERS

Same Price and Mounting Dimensions as Miller 2000-3000 PSI Hydraulic Cylinders.

BOTH LINES MADE POSSIBLE BY SHEF SEAL

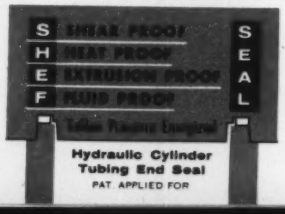
Write For New Hydraulic Cylinder Bulletin

MORE MILLER "FIRSTS"

MILLER FLUID POWER

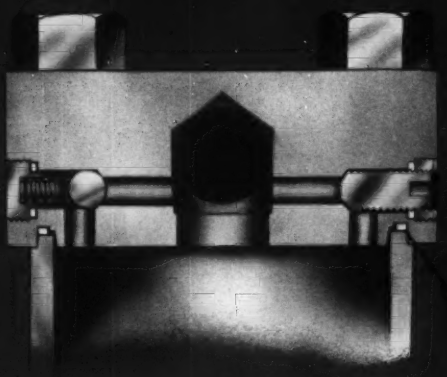
OTHER MILLER QUALITY FEATURES

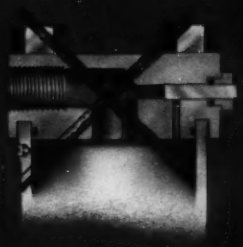
- All Teflon Sealed Against External Leakage—Teflon Cups Extra
- Case-Hardened Chrome Plated Piston Rod
- Shear Proof Rod Bushing Seal
- Ball Check Interchangeable with Self Sealing and Locking Cushion Adjustment
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers



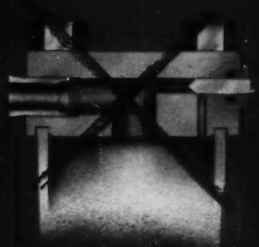
Miller

SHEF SEAL Obsoletes All Other Hydraulic Cylinder End Seals . . . *at no added cost*





"O" RING



GASKET

SHEF SEAL HAS EVERY ADVANTAGE

NONE OF THE DISADVANTAGES OF OBSOLETED "0" RING AND GASKET CONSTRUCTION

Shearproof! Location of Teflon sealing ring eliminates blind assembly, makes shearing impossible. One sealing ring cross section dimension for all cylinder sizes—supplied on convenient spools.

Blind "0" ring assembly can shear rings and create difficult servicing problems. Large inventory required for servicing varying cylinder bores. Gasket construction unpredictable—outlawed by J. I. C. eight years ago.

Heatproof! Teflon sealing ring provides leakproof sealing at temperatures from —100° F. to plus 500° F.

Gaskets and "0" rings require extra inventories of special synthetic compounds to meet various operating temperatures.

Extrusionproof! Zero metal-to-metal clearance at all pressures provides perfect seal backup. Sealing ring cannot extrude at any pressure, permitting higher operating pressure ranges.

Gaskets can leak and blow even at low temperatures. "0" ring extrusion is one of the most prevalent causes of hydraulic cylinder repairs and maintenance.

Fluidproof! Teflon sealing ring seals perfectly and permanently against all known hydraulic fluids including fire-resistant types.

"0" rings must be specially compounded for use with different hydraulic fluids. This means large, expensive inventories.

OTHER DESIRABLE FEATURES

SHEF SEAL is a pressure energized seal—its sealing effectiveness increases with pressure. It allows air bleeds in head and cap for remote or automatic bleeding. Its zero metal backup clearance eliminates dangerous leaks and spurts of fluid due to seal failure. Head and cap axial movement does not destroy seal.

ELIMINATE THESE DISADVANTAGES

"0" ring construction requires location of air bleeds in cylinder tubing. Failure of gaskets and "0" rings causes leaks and spurts of fluid that create dangerous fire and safety hazards.

SHEF SEAL—*Another Miller "First"*

OTHER MILLER QUALITY FEATURES

- All Teflon Sealed Against External Leakage—Teflon Cups Extra
- Case-Hardened Chrome Plated Piston Rod
- Shear Proof Rod Bushing Seal
- Ball Check Interchangeable with Self Sealing and Locking Cushion Adjustment
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers

MILLER FLUID POWER

Turn Page For More About MILLER

Miller

All Teflon* Sealed —Perfect Sealing for Hydraulic Cylinders

HAS EVERY ADVANTAGE...

Teflon—As Static and Dynamic Seals

1. Impervious to Every Hydraulic Fluid Including Fire-Resistant Types.
2. Seals Perfectly in Cylinders at Temperatures from —100° F. to 500° F.
3. Can Be Molded Into Shapes That Have Zero Leakage—Hold Pressure Indefinitely.
4. With Proper Design of External Seal Cavities, Teflon Can Be Included *Without* Increasing Prices. Miller Provides Teflon for all External Seals at Prices Competitive with Ordinary Cylinders. Leather Internal Piston Cups are Standard (Teflon Cups Extra).

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Printed in U.S.A.

*du Pont trademark for its tetrafluoroethylene resin.

When you buy Miller
You buy extra years
of worry-free
Cylinder performance
...at competitive prices

NONE OF THESE DISADVANTAGES

Synthetic Rubber— As Static and Dynamic Seals

1. Unsatisfactory Except When Used With A Limited Range of Hydraulic Fluids.
2. Even Uncontrollable Changes in Fluid Additives Often Destroy Seal.
3. Specific Compounds Needed for Compatibility with Specific Fluids Normally Used Today.
4. Normal Temperature Range Limited to 0° F. to 130° F. Slightly Reduced Life When Operated at 130° F. to 150° F. Greatly Reduced Life at 150° F. to 250° F.
5. External Leakage Causes Fire and Safety Hazards When Temperature or Fluid Destroys Seals.
6. "U" Type Seals Without Mechanical Retainer at Mid-Section Frequently "Roll" and Lose All Sealing Ability.

Resin Impregnated Leather— As Dynamic Seals Only

1. Is Compatible with Many—But Not All—Hydraulic Fluids and Additives Including a few Fire-Resistant Types.
2. Normal Temperature Range Limited to —60° F. to 130° F. Slightly Reduced Life When Operated at 130° F. to 150° F. Substantially Reduced Life at 150° F. to 250° F.
3. External Leakage Causes Fire and Safety Hazards When Temperature or Fluid Destroys Seals.

   Miller Uses Leather Piston Cup Seals for Internal Sealing... Standard Price (Teflon Cups Extra).

Piston Rings— As Dynamic Internal Seals

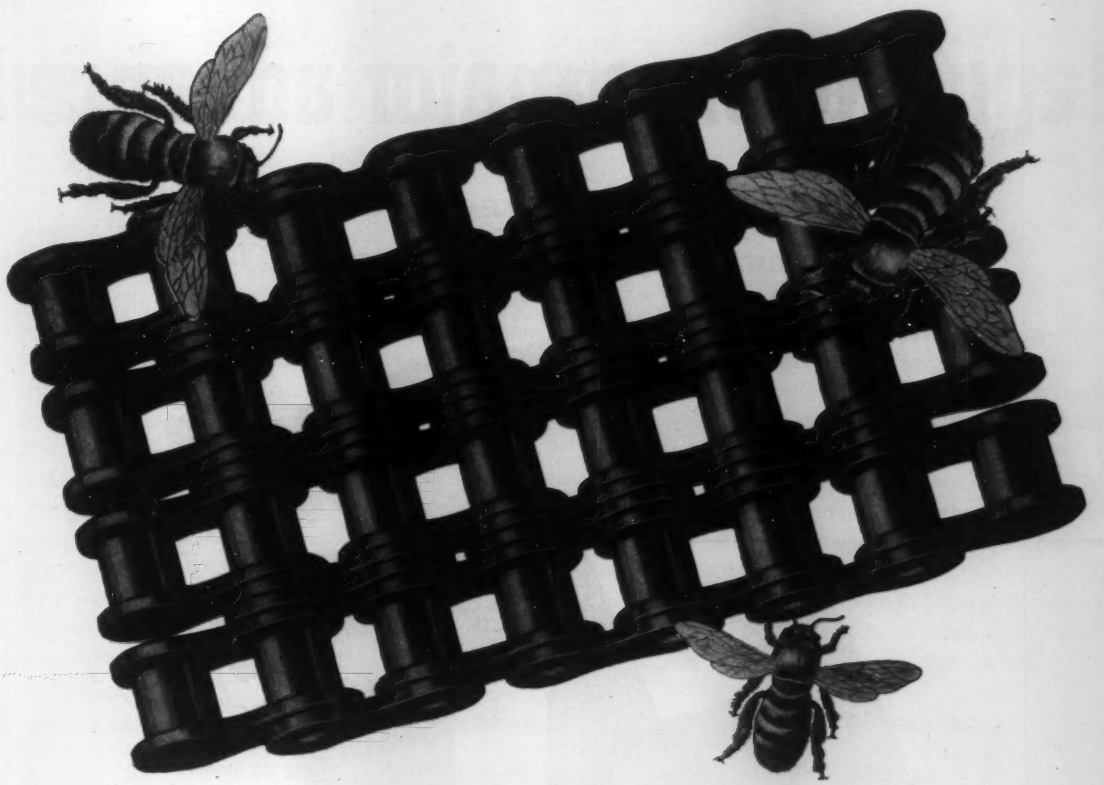
1. Most Piston Rings Allow Some Leakage.
2. Allow "Slip" or "Drift" of Piston Due To Leakage—Unsatisfactory for Many Applications.
3. Allow Varying Feed Rates Due To Leakage Because Of Viscosity Change During Startup—Unsatisfactory for Most Multiple and Automated Operations.
4. Allow Some Pressure Loss.
5. Chips and Dirt Enter Space Between Piston and Tube Causing Scoring —Especially During Startup.

Write For New Hydraulic Cylinder Bulletin

OTHER MILLER QUALITY FEATURES

- All Teflon Sealed Against External Leakage—Teflon Cups Extra
- Case-Hardened Chrome Plated Piston Rod
- Shear Proof Rod Bushing Seal
- Ball Check Interchangeable with Self Sealing and Locking Cushion Adjustment
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers

MILLER FLUID POWER
2006 N. Hawthorne Ave., Melrose Park, Ill.



FACTS OF LIFE . . .

Facts which concern the designer of modern equipment are top efficiency, adaptability and minimum over-all cost.

Whitney's Self-Lubricating Single and Double Pitch Roller Chain and *fatigue resistant* Processed Roller Chain are design advancements answering these needs for machinery manufacturers and users in many industries.

First, Whitney's amazing Self-Lube Chain outlasts regular chain by as much as 5 to 1 under toughest field conditions of continuous exposure to dust and moisture. Here, Whitney's exclusive sintered steel chain bushings "oil cleanly from the inside." . . . are prelubricated for life, cannot trap abrasive matter that cuts chain life. Ideal for applications in food, drug, textile and many industries where external chain lubrication is not practical or desirable.

And Whitney's *fatigue resistant* Processed Roller Chain is establishing new service standards for durability, particularly on problem drives involving unusual operational conditions, stresses and heavy shock loads. This performance comes from the exclusive Whitney process which offsets excessive operational stresses in the chain.

These new dynamic, balanced chain designs serve better, longer and at less over-all cost. And so does the entire Whitney line of A.S.A. Roller, Silent and Conveyor Chain Drives . . . all precision engineered for top quality.

Whitney Field Engineers provide nation-wide consultant service, backed up by company operated warehouses and alert Whitney Distributors offering a complete off-the-shelf stock service. If you want RESULTS specify WHITNEY CHAIN.

CREATORS OF SELF-LUBE CHAIN

Whitney

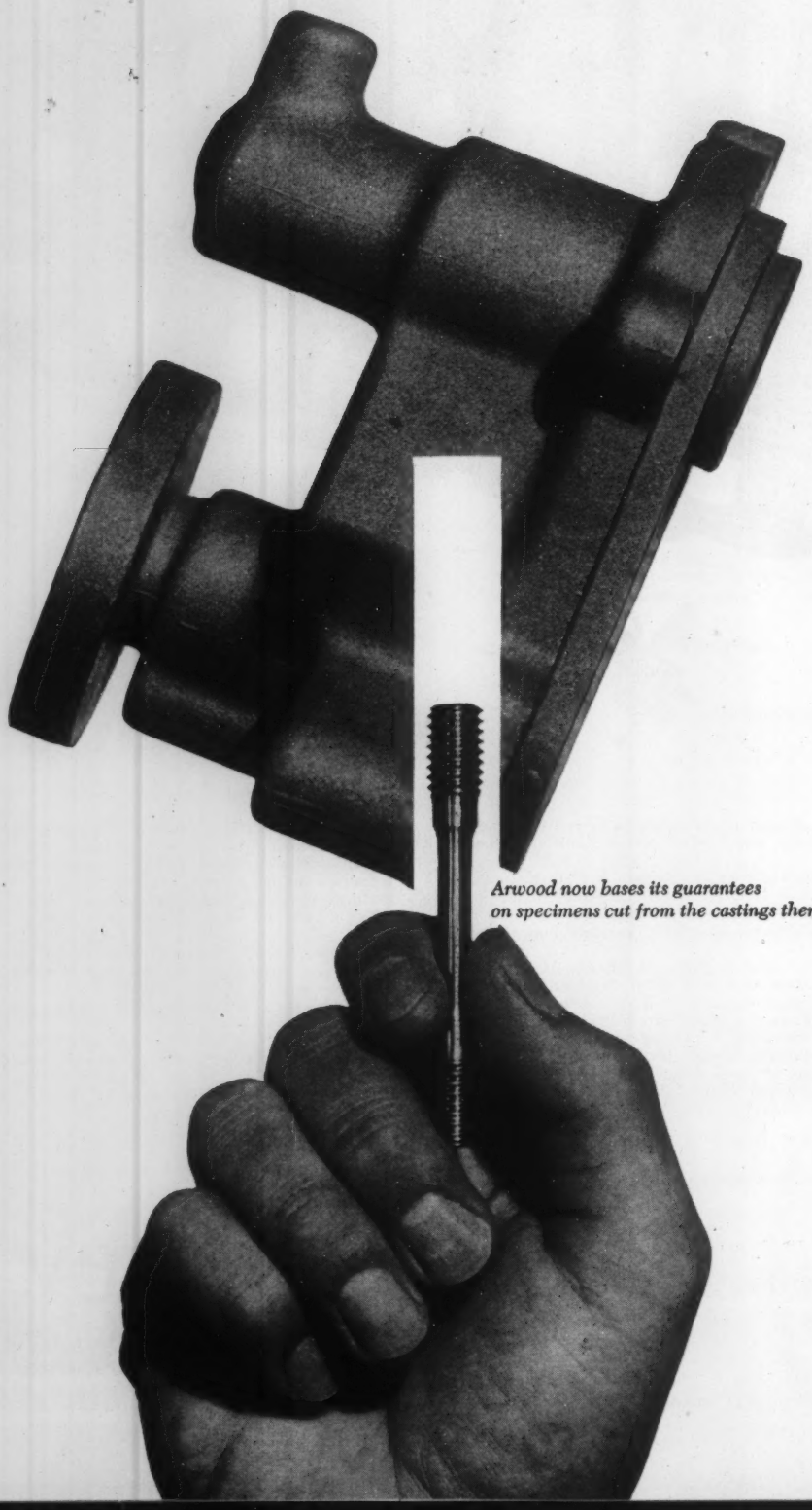
CHAIN COMPANY

205 HAMILTON ST., HARTFORD 2, CONN.

ROLLER CHAIN • SILENT CHAIN • CONVEYOR CHAIN • SPROCKETS • FLEXIBLE COUPLINGS

Circle 426 on Page 19

Now—a major advance in



Arwood now bases its guarantees on specimens cut from the castings themselves.

aluminum investment castings!

Arwood now guarantees better-than-Aircraft-Quality properties in the casting itself

Arwood's Research Staff has perfected a new technique of investment casting aluminum . . . a technique that makes it possible to guarantee mechanical properties far higher than Aircraft Quality and guarantee them in the casting itself. The new Arwood "Suparcast" process gives you 37% greater tensile strength . . . 52% greater yield strength . . . a threefold improvement in elongation . . . in all areas of the casting. In stressed areas, these minimums can be raised even higher!

And here's the real news: *These guarantees are based on specimens machined from actual castings.*

It's easy to understand how the new "Suparcast" process can help you shuck off the historical limitations of aluminum investment castings. Now at last you know exactly what properties you are getting in your castings. Now at last you can use aluminum investment castings for structural applications, even where shock and impact are involved.

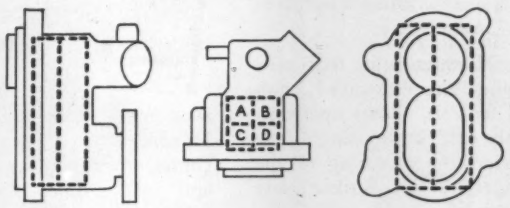
Another very practical consideration: If you are now using 356-T6 alloy investments, you can switch to castings made by Arwood's "Suparcast" process *without the need to change specifications.*

If you'd like to learn more about Arwood's new process, write, wire or 'phone for complete details.

COMPARISON OF MINIMUM MECHANICAL PROPERTIES OF 356—T6 ALUMINUM ALLOY
Suparcast Guaranteed Minimums vs. Government Aircraft Quality Minimums
(Test bars cut from castings weighing less than five pounds and with maximum sections less than 1" thick.)

	Ultimate Tensile Strength		Yield Strength		Elongation	
	psi	% increase	psi	% increase	%	% increase
AMS 4260	24,750	—	16,500	—	0.7	—
Arwood Suparcast (all areas)	34,000	37.4	25,000	51.5	3	300
Arwood Suparcast (critical areas)	38,000	53.5	27,000	63.6	5	600

HERE ARE ACTUAL MECHANICAL PROPERTIES IN VARIOUS AREAS OF THE CASTING SHOWN AT THE LEFT:



Test bar location	Ultimate (psi)	Yield (psi)	Elongation %
A	38,800	28,400	5
	37,600	28,600	4½
B	38,800	28,600	4
	37,500	27,000	5
C	41,300	29,200	9
	39,800	27,400	6
D	40,000	26,500	5
	37,400	27,600	4

arwood

ARWOOD PRECISION CASTING CORP.
315 West 44th Street, New York 36, New York

A complete service from design through tooling, production and finish machining. Sixty-two engineering consultants from coast to coast.

PLANTS IN BROOKLYN, N. Y.; GROTON, CONN.; TILTON, N. H.; LOS ANGELES & N. HOLLYWOOD, CALIF.

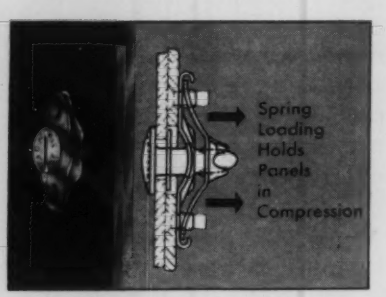
Circle 427 on Page 19

Quick-Opening Fasteners

Selecting Small Fastenings for Metal Closures

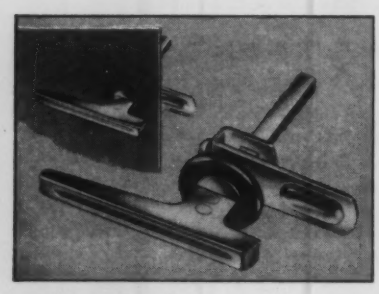
*"Use captive fasteners wherever feasible . . . Avoid the use of loose washers and loose nuts . . . Fasteners on equipment covers should be operable either with no tools or with standard hand tools"**

(John D. Folley, Jr. & James W. Altman, Research Scientists, American Institute for Research)



Quarter-Turn Fastener

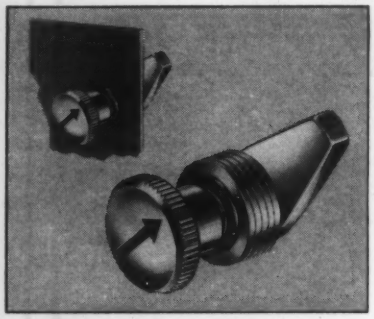
Lion Fasteners open and close with a ¼ turn, hold sheets tightly under the compression of a rugged spring. Quickly operated and fully retained in the outer panel, they are approved under U. S. Government military specifications. Stud and receptacle float for easy alignment and simplified hole preparation. Flush, oval, wing, knurled, ring, and key head styles available. Sizes—No. 2, No. 5, and High Strength for extra heavy duty.



Cabinet Latch

Just drill a hole, push the fastener stem through, and slide the special push-on clip into place. No welds, screws, bolts or rivets: the fastener is permanently installed in seconds!

Adjustable to any grip length or panel thickness, the pawl is fixed in place by a single set screw. The fastener's brightly finished knob is set off by a plated washer. Also furnished with screwdriver operated flush head.

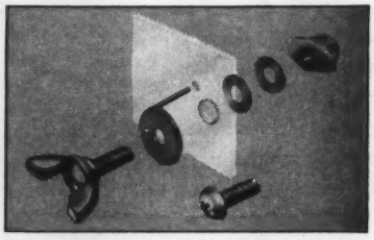


Spring Tension Latch

For fastening slide-out drawers and hinged panels the Southco Arrowhead Latch is recommended. It locks or opens with a quarter turn yet occupies less than ½" inside space.

Doors are held under spring tension—a push against the arrowhead knob relaxes this tension, allows operation with fingertip ease. Drill a single hole for installation—no fastening to the door is necessary. No striker plate is needed.

Pawl stop is eliminated—arrowhead shows at a glance exact position of pawl.



Adjustable Panel Latch

Small doors and panels can be fastened with greatest speed and lowest cost with the Southco Adjustable Latch.

The entire fastener is quickly installed through two holes punched in the door; no bolts or rivets are needed.

It operates with a quarter turn, requires no striker plate. An extra twist after the nylon pawl is engaged pulls up the door to form a seal and eliminate vibration.

Available with wing, knurled, or Phillips head.

Free Fastener Handbook

Send for your free copy of Fastener Handbook No. 7, just released. Gives complete engineering data on these and many other special fasteners. Fifty-two pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.

SOUTHCO FASTENERS
LION

©1956

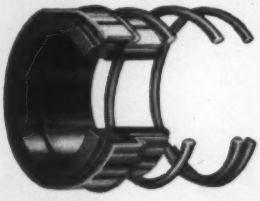
* *Quotation from "Designing Electronic Equipment for Maintainability"; Machine Design, July 12, 1956.*

Victor's Proven Answer to Rotary Shaft Sealing

On water pumps... appliances... automotive and industrial equipment

Victo-Seal Type 6 Axial Face Seal with Victoprene outside diameter. Easily installed and removed. Metal parts completely encased in Victoprene diaphragm to which seal ring is bonded.

Typical Proven VICTOR Designs



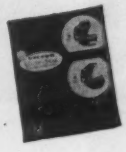
Victo-Seal Type 2 Axial Face Seal. Its efficiency in preventing leakage on rotating shafts is well known. Also seals against end plates.

Victo-Seal Type 7 End Face Seal with metal outside diameter with fully protected rubber-enclosed spring.

Victo-Seal Features

- Made with Victoprene elastomer diaphragms
- Simple, self-contained units
- Easily, economically installed on production line, in repair shops, in the field
- Positive torque lock that eliminates diaphragm fatigue, maintains constant unitary function
- Self-aligning—compensates automatically for wear, shaft movement; absorbs vibration
- Controlled pressure contact between sealing surfaces maintained by long-life compression spring
- Moderately priced
- Victor well-known quality throughout—in design, construction, materials

Send for fully descriptive literature



Literature is available through your Victor Field Engineer, or on request. Please state nature of application. Write Victor Mfg. & Gasket Co., P. O. Box 1333, Chicago 90, Ill. In Canada: Victor Mfg. & Gasket Co. of Canada Limited, Victor Drive and Chester St., St. Thomas, Ont.

VICTOR

Sealing Products *Exclusively*

GASKETS • OIL SEALS • PACKINGS • MECHANICAL SEALS

Circle 429 on Page 19

New tool balancers boost production... relieve fatigue

Seven new Keller Tool Balancers designed to increase production . . . reduce fatigue . . . prevent tool dropping damage. Three models for light suspension of screw drivers, nut setters, drills, tappers. Four models for heavy-duty balancing in 20—30—40—50 lb. capacities.

- ★ **LONG SERVICE—oilless alloy bronze bearings.**
- ★ **ADJUSTABLE CABLE STOP—shock-resisting bumper.**
- ★ **CABLE GUIDE—keeps proper position on drums.**
- ★ **STRAIGHT-LINE PULL—eliminates excessive wear.**

Many other features. Ask for Catalog Section 65.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER - DENVER

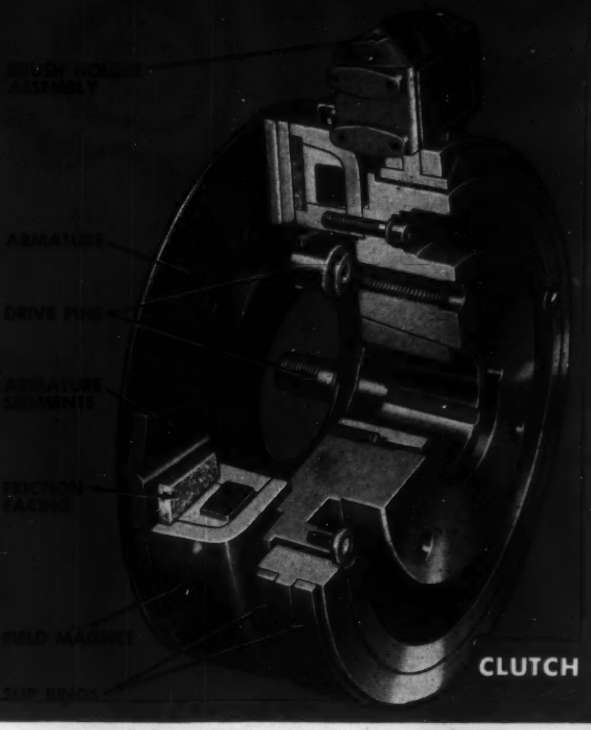
Gardner-Denver Company, Quincy, Illinois

Circle 430 on Page 19

The New EATON Dyna-TORQ

MAGNETIC-FRICTION CLUTCHES, BRAKES, CLUTCH-BRAKES, CLUTCH-COUPLINGS

Are the Accurate, Trouble-Free Means of Controlling Power and Motion in Modern Stop-and-Go Machines



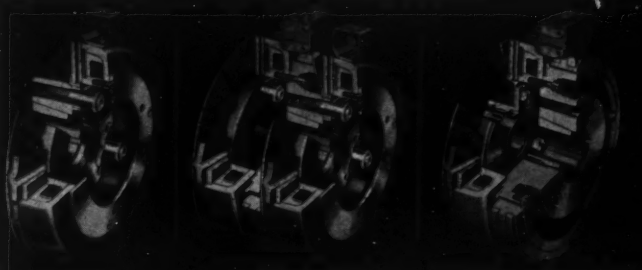
CLUTCH

The Eaton Dyna-torQ electro-magnetic friction units include a number of unique design advancements which provide longer life and superior performance with less maintenance. Check the following important advantages:

1. **Extremely Rapid Response in Clutching and Braking**—makes Dyna-torQ units ideally suited to a wide range of manual and automatic cycling applications.
2. **Smooth, Shockless Engagement**—permits rapid operation without backlash or chatter.
3. **Highly Effective Cooling**—maintains lower operating temperatures; permits fast, repetitive actuation.
4. **Self-Adjustment**—automatically maintains proper clearance between armature shoes and field magnet.
5. **Simple, Accurate Control**—manual or automatic; may be had to operate on 110, 220, or 440 volt, 60 cycle, alternating current.
6. **Low Maintenance Costs**—result from unique design features and superior quality of construction, assuring long operating life and minimum down-time.

Eaton Dyna-torQ Clutches and Brakes are electrically operated, disc-type friction units having two basic components: a field magnet and an armature. Torque is transmitted as the magnet pulls the armature into engagement. Because the pull of the magnet is direct without intricate linkage, and the movement of the armature is slight, Dyna-torQ units are capable of extremely rapid response in clutching or braking.

Ask us to tell you how these Dyna-torQ units will fit your equipment.


BRAKE CLUTCH-BRAKE CLUTCH-COUPLING

WIDE RANGE OF SIZES AND CAPACITIES

Send for Illustrated Descriptive Literature

EATON

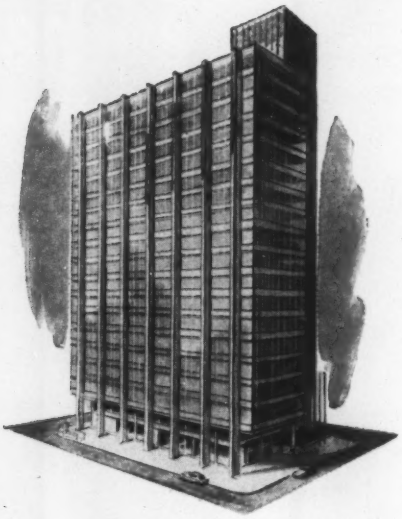
DYNAMATIC DIVISION

MANUFACTURING COMPANY

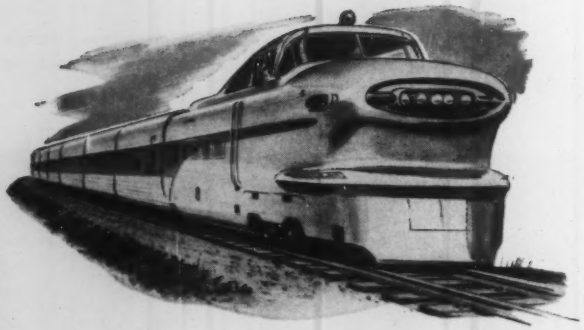
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

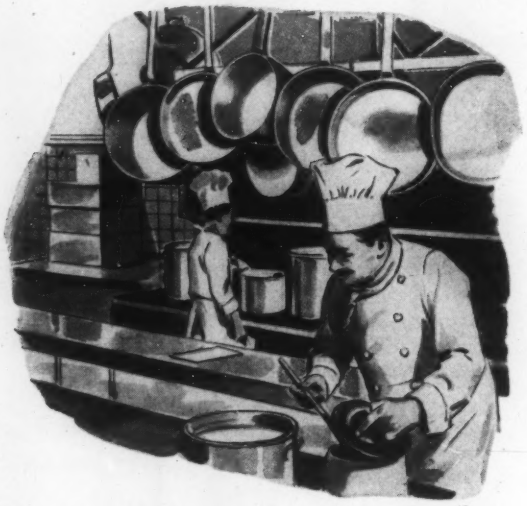
Circle 431 on Page 19

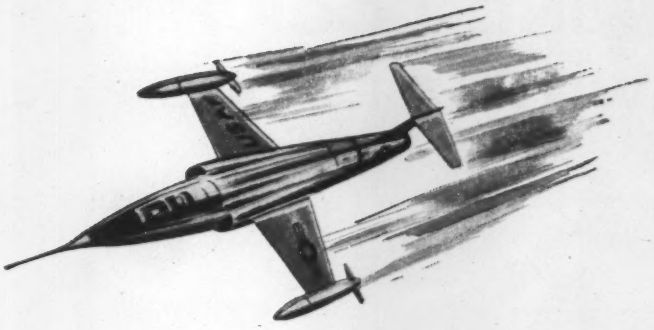
Metals do more all the time... Thanks to Alloys

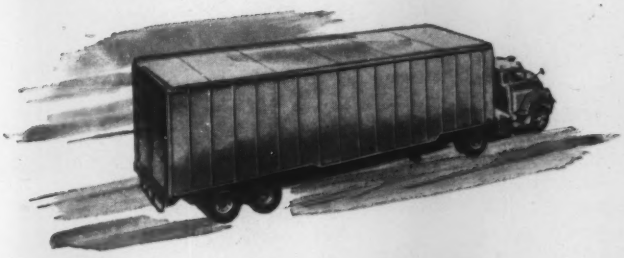


Look what's happened to "200" Series









Stainless Steels

Growing demand...availability...economy are putting these useful steels into more and more new products

Manufacturers are finding "200" Series Stainless Steels *equally* practical for such different applications as kitchen utensils, truck bodies, building trim, appliances and automobile trim—to name a few. The usefulness and application of "200" Series Stainless Steels *grow* as designers, fabricators and marketers discover how well they combine strength, beauty, and corrosion resistance with low cost.

ELECTROMET produces more than 100 alloys, including those containing chromium, manganese and nitrogen for making "200" Series Stainless Steels. These steels are the result of basic work carried out at ELECTROMET's research laboratories. Stainless steel producers have been granted royalty-free licenses under patents covering these developments.

Learn more about these new and useful steels. In economy . . . in availability . . . in practicality—they might well solve your current manufacturing problems. Send for booklet 44. Electro Metallurgical Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. In Canada: Electro Metallurgical Company, Division of Union Carbide Canada Limited, Toronto.

Electromet

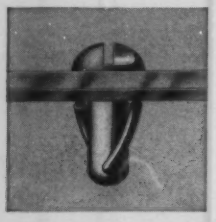
FERRO-ALLOYS AND METALS

UNION CARBIDE

The terms "Electromet" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

How can you use SPRING-LOCK?

THE FASTENER WITH USES UNLIMITED

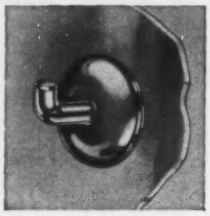


As a standard removable fastener or a blind rivet

A quarter-turn locks, unlocks. Load-carrying steel arms lock securely, don't loosen under vibration. One-piece (no receptacle) simplifies blind fastening.

As a roller axle

Now used on range drawers, kitchen cabinets, file cabinets, desks. Cuts installation costs, saves time. Designed to suit. Available with or without roller.

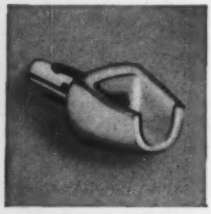


As cup hooks

High-strength polystyrene or chrome-plated die cast zinc. Inexpensive, sturdy and good-looking. Simply and quickly installed with a twist of the wrist.

As a cabinet door strike

Millions in use on kitchen cabinets, automatic dishwashers, etc. Standard strikes available from stock, or custom designed for special contour requirements.



As a plastic shelf support

. . . with the heart of steel for extra strength. Millions now used by all major refrigerator manufacturers. Complete flexibility of head design.

What is <u>your</u> application for

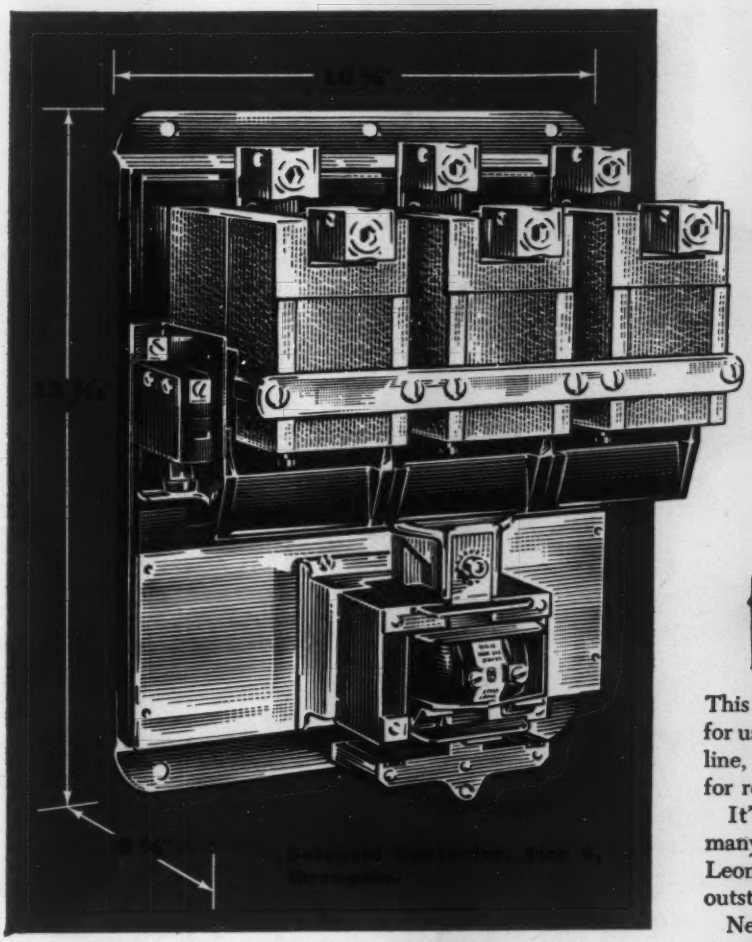
SPRING-LOCK?

Send us your application inquiries. Our engineers will answer you specifically and promptly. Or, write today for the Simmons Catalog. SPRING-LOCK samples are available upon request.

SIMMONS FASTENER CORPORATION

1756 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • ROTO-LOCK LINK-LOCK • DUAL-LOCK



NEW 150-amp solenoid contactor extends proven line

This new Size 4 A.C. solenoid contactor is ideal for use in motor starters and controllers for main line, accelerating and reversing purposes and for resistance heating and lamp loads as well.

It's the new Bulletin 4454—incorporating many advanced design features found on Ward Leonard's Sizes 0 to 3 contactors. Check these outstanding features:

New sintered-silver-cadmium-oxide contacts—can repeatedly handle high inrush currents without a sign of contact welding, excessive pitting or other damage.

Simple, compact solenoid design—excellent for modern metal control panels using accessible front-of-board wiring, particularly useful where panel space is limited.

Available with two or three main poles and up to 4 side-mounted auxiliaries. Also with provision for mechanical interlocking and addition of overload relays.

Completely described in Bulletin 4454. Write for your copy today. The Ward Leonard Electric Co. 58 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada Ltd., Toronto.) 7.6

ENGINEERING DATA

Size 4 A.C. Contactor Ratings*

Service	8-Hour Ampere Rating		Enclosed Power Rating	
	Open	Enclosed	Three Phase Volts	H.P.
Across-the-Line Starting	150	135	110 220 440-550	25 50 100
Across-the-Line Plug-Stop or Jogging	150	135	110 220 440-550	15 30 60

Service	8-Hour Ampere Rating	Single Phase Volts	Single Phase K.W.	Three Phase Volts	Three Phase K.W.
Resistive Heating Load**	150	110 220 440 550	15 30 60 75	110 220 440 550	26 52 105 130
Tungsten Lamp Lighting or Infrared Heating Load**	120 Amperes for 250 Volt Circuits or Less				

*The ratings listed are those recommended by the National Electrical Manufacturers Association.
**These ratings apply to open or enclosed contactors.

LIVE BETTER...*Electrically*

Why jet engines are harnessed with *Carpenter* Welded Stainless Tubing

Reason One: For measuring their exhaust temperature. They're harnessed with the circular assembly of 1″ O.D. Type 430 Carpenter Tubing shown above. Inside it are two wire loops connected to thermocouples on the engine tail-cone. Made in diameters of 12″ to 36″, this harness has to withstand up to 1000-degree heat, corrosive fuel and atmosphere, engine shock and vibration.

Reason Two: Type 430 Carpenter Tubing provided *more* than the strong resistance to heat, corrosion and shock, and the low coefficient of expansion required in this punishing service. Being *welded* tubing, its uniform walls, working properties and dimensional accuracy to 0.003″ throughout were important production advantages for the "harness-maker". Precise bending, flaring and other fabricating operations were accomplished trouble-free.

Next time you need stainless tubing for pressure, corrosion resistance, mechanical, structural or sanitary requirements, call in your nearby Carpenter Representative or Distributor. Have him tell and show you why the quality and uniformity of the welded tubing he sells saves time, trouble and money. Meantime, send for Selecting and Buying Guide, Bulletin T.D. 120.

You are sure of getting all these tubing advantages from Carpenter:

• Uniform wall thickness throughout the length of the tube • Smooth surfaces, I.D. & O.D. • Uniform analysis • Guaranteed 100% pressure tight • Maximum workability • Full corrosion resistance throughout • Heat exchanger quality • Widest range of analyses • Lower initial cost.

The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

Carpenter

more than corrosion resistance

Stainless Tubing & Pipe

(Advertisement)

Design data on adhesives

Armstrong
ADHESIVES • COATINGS • SEALERS

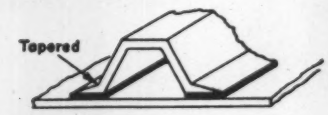
NUMBER FIVE

How to minimize peel by changing stiffness

When stiffening members are attached to thin sheets, the sheets may deflect in service and set up peel stresses on the adhesive. Such peel stresses exerted on rigid adhesives can cause failure. Some structural adhesives, however, resist peel more than others. Proper design, too, can help.

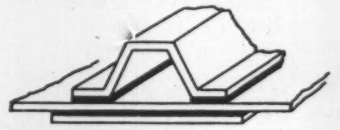
For example, if the flanges on the stiffening section can deflect with the sheet, the peel problem will be minimized. Thus, reducing the stiffness of the flange on the stiffening section should result in improvement . . . as will increasing the stiffness of the base sheet itself. How stiffness may be changed to minimize peel is shown below.

Basic assembly



Reduce flange stiffness with taper

Reduce flange stiffness with grooves



Increase base sheet stiffness with extra member

If you have a design problem involving adhesive bonding, we may be able to suggest a practical, economical solution based on our 36 years of experience in making and using adhesives, coatings, and sealers. Send details of your problem to Armstrong Cork Company, Industrial Div., 8011 Dean St., Lancaster, Pa.

BONDING METHODS:
Wet assembly and contact bonding

Basically, assembly with adhesives involves placing cleaned and coated parts together, with the surfaces to be bonded held in intimate contact until the adhesive sets. There are various techniques for doing this, depending on the materials, their shapes, and the properties of the adhesive.

Wet Assembly

This technique involves bringing the bonding surfaces together while the adhesive is liquid and holding them in this position with pressure until the adhesive sets or develops its bonding strength.

BONDING VINYL TO METAL. Here, adhesive is being sprayed on the vinyl covering and end posts of a folding door. This kind of application, where clamping is impracticable, requires an adhesive with high immediate strength.

With porous materials such as wood or paper, adhesives used can set chemically, or through the loss of volatile material, or merely through cooling as with hot melts. With nonporous materials, such as metal and plastics, loss of volatile material is practically impossible except at edges. With these materials, the adhesives used must be of the kind that set through chemical action, through cooling, or through polymerization or condensation at high temperatures. Or the bonds may be made when practically all the solvent is out as with "contact" adhesives.

In wet assembly, relatively low pressure is required while curing, and it is easy to obtain accurate alignment if mistakes in position are noticed before the adhesive sets. In addition, no floor space is needed for drying of adhesive-coated parts being prepared for assembly. On the other hand, pressure jigs may be necessary during curing, and on large operations, the amount of floor space involved can be substantial.

Contact Bonding

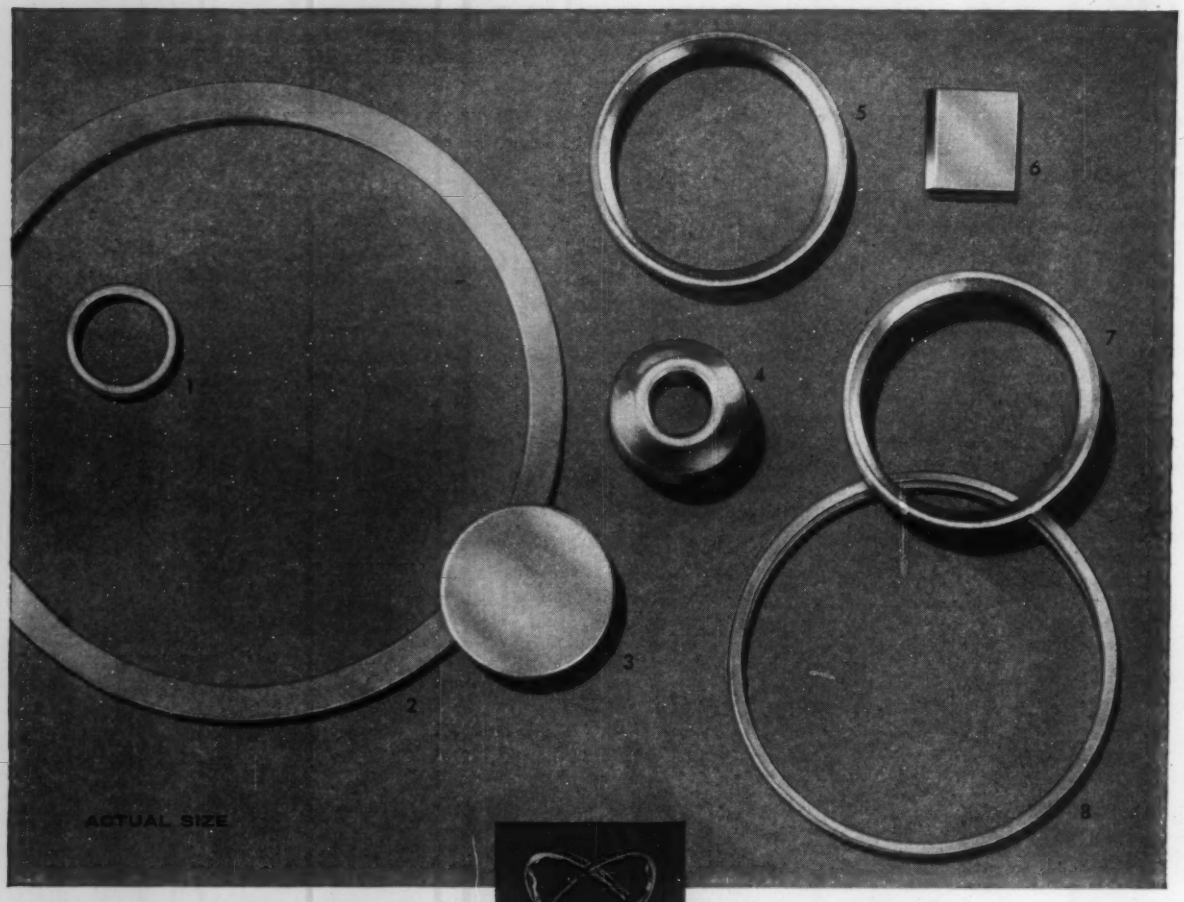
This method requires only the application of pressure to adhesive-coated surfaces to accomplish the bonding. With contact adhesives, coating of only one surface is usually required.

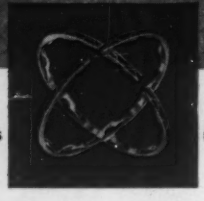
Contact adhesives, with inherently higher strength than softer, truly pressure-sensitive products, generally work best when both surfaces are coated. However, if the adhesive is applied to only one surface, more solvent must be present in the film at the time of assembly to permit transfer of the adhesive. With Buna-N, neoprene, and reclaim-rubber adhesives, there is generally enough residual "tack" in the films after solvent evaporation, but tack range varies with each adhesive.

In joining nonporous surfaces, both surfaces should be coated, and the maximum amount of solvent should escape before assembly. Where one of the surfaces is permeable, however, the adhesive films need not be so dry. In bonding impervious materials with adhesives that lack adequate tack range for easy assembly, an inter-liner of cotton duck or chipboard will help the volatile material to escape. Then, the adhesive can be used in a softer condition than permissible where no volatile escape is possible.

Generally, contact adhesives develop a reasonable bonding strength as soon as assembly is completed. Pressure requirements are usually low —often a hand roller will do the job —and pressure need be applied only long enough to ensure full contact.

Circle 436 on Page 19



From the producer of piston rings  used in 1 out of every 3 new cars . . .

New economies for you in powdered metal parts

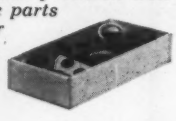
Muskegon's Sparta Foundry—pioneer and foremost producer of sintered powdered metal piston rings—can form small sintered powdered metal sealing rings and parts for you at lower costs than ever before. Sparta's technological advancements and extensive production facilities make this possible.

In addition to the greater strength and longer wear, Sparta sintered powdered metal parts offer the advantages of smaller, narrower size with no trim or waste. Closer tolerances and more accurate measurements can be maintained, oil retention qualities can be improved. Savings in metal and machining are truly impressive.

(1) Small engine piston ring blank. (2) Automotive piston ring blank. (3) Finished valve pressure disc. (4) Rocker arm ball valve. (5) Automatic transmission ring blank. (6) Refrigerator compressor rotor blade. (7) Camshaft spacer ring. (8) Clutch spring retainer ring.

SEND FOR YOUR FREE SAMPLE KIT

It contains a miniature assortment of precision sintered powdered metal parts and precision iron and bronze sand castings. These parts typify how Sparta can reduce or completely eliminate your finishing and machining operation. Write today! Sparta Foundry Co., Sparta, Mich.



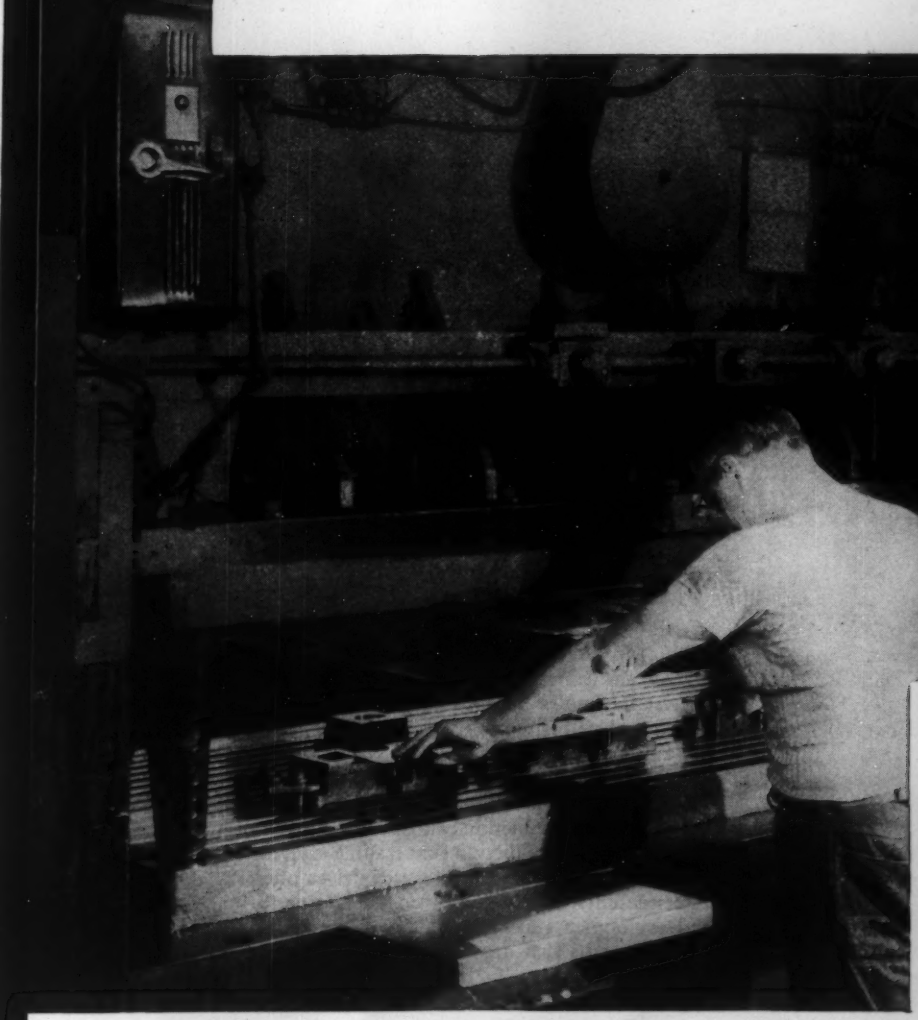
MUSKEGON Piston Ring Co.

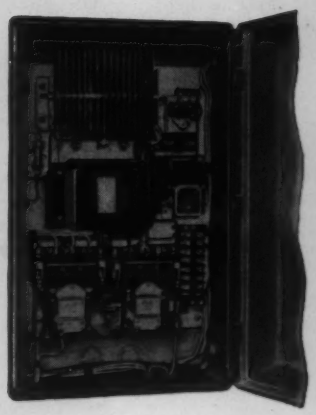
PLANTS AT MUSKEGON, MICHIGAN SPARTA, MICHIGAN
ROTARY SEAL DIVISION PLANTS AT SPARTA, MICHIGAN CHICAGO, ILLINOIS

Since 1921... The engine builders' source!

IMPROVE MACHINE TOOL PERFORMANCE

—with Westinghouse components ...ready today



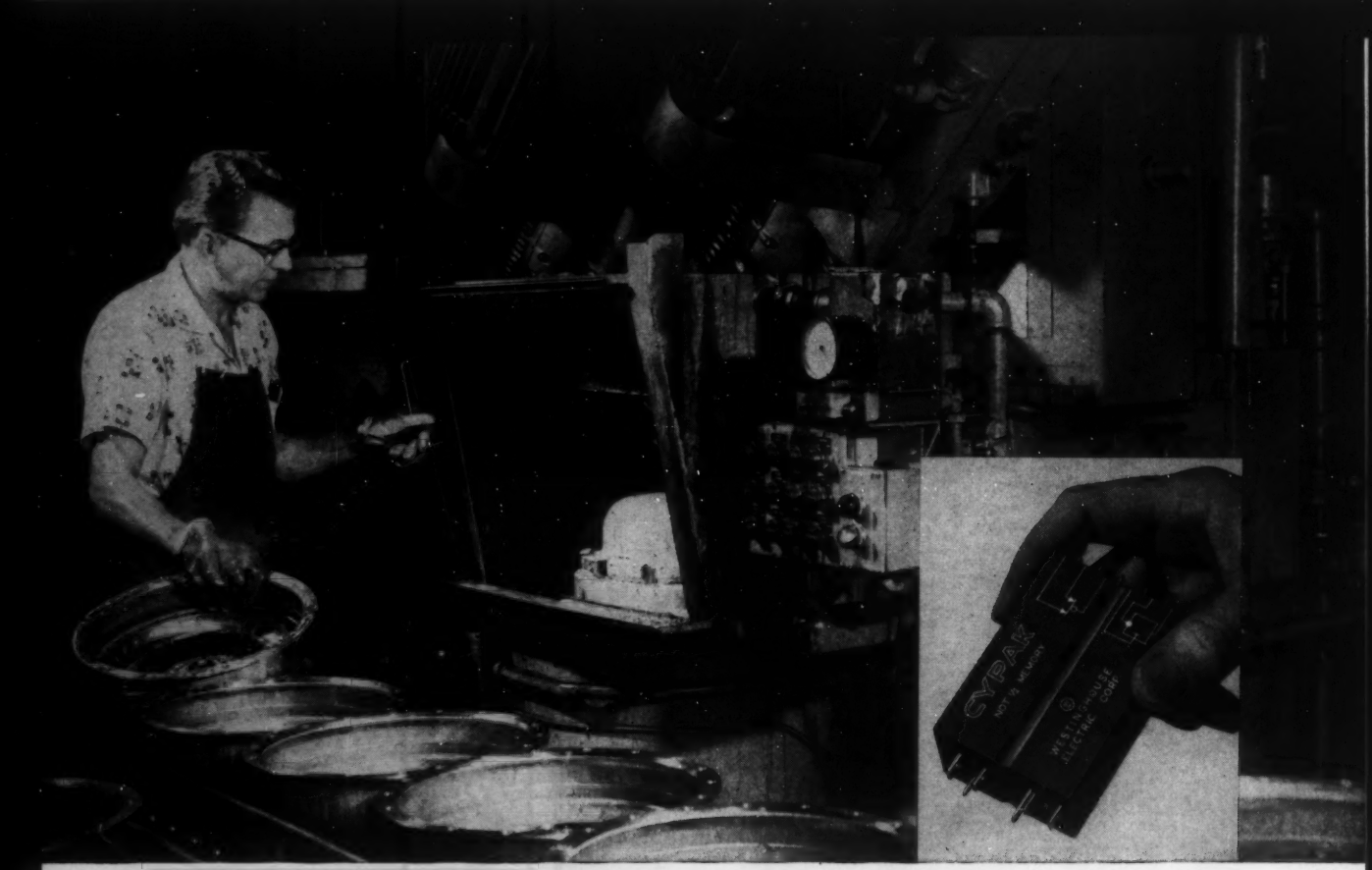


Stamping press performance improved at this plant when they used Westinghouse DYNAC braking control to reduce stopping time 95 percent.

MP-3057-1

YOU CAN BE SURE...IF IT'S Westinghouse

Circle 438 on Page 19



Westinghouse Cypak static control reduces maintenance costs in form-grinding automotive transmission parts.

THESE COMPONENTS OFFER IMMEDIATE ANSWERS

...for more dependable operation
...for quicker stopping...for faster duty cycles

You don't have to wait for electrical answers in making machine tool improvements or modifications. Outstanding design and improvement in Westinghouse control components, systems and drives help designers and their customers to act now.

For example, *Westinghouse DYNAC® braking control*, cover photo, reduces press stopping time 95 percent. The eight minutes it previously took to stop the heavy flywheel on this press have been cut to just 24 seconds with DYNAC. This operation is now getting the fastest, smoothest stops possible to increase production.

Cypak static control*, above, has already outlasted conventional relays previously used on form grinders at a large automobile manufacturer's plant. No down time for control maintenance has been necessary on this highly repetitive operation in over 17 months.

*Trade-Mark

Westinghouse Life-Line® "H" Motors, right, make possible faster, smoother reversing cycles to save production time. Westinghouse reduced armature inertia up to 55 percent and increased commutating ability 35 percent to provide in the Life-Line "H" Motor the fastest d-c motor response available to improve machine tool performance.

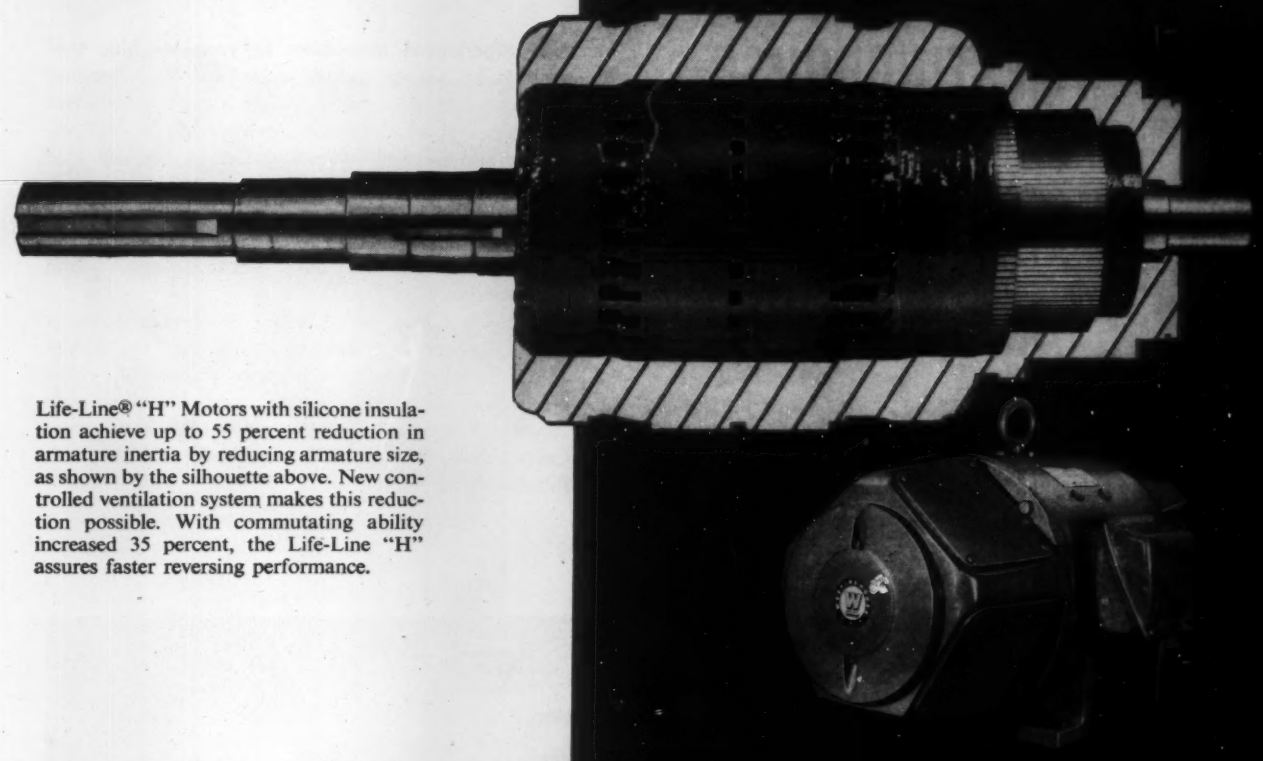
Westinghouse right-angle gearmotor, right, delivers up to 195 percent more torque capacity than conventional single-reduction worm gearmotors between 9:1 and 60:1 speed reduction ratios. It's the result of more efficient, double-reduction gear train. You'll find Westinghouse packaged motor-reducer drives offer rugged dependability, too, for improved machine performance.

Developments like these help you design and build machine tools that answer your customers' needs for increased productivity at lower cost. Whatever the function you want performed . . . sensing, transmitting, recording, computing, control or driving . . . think of Westinghouse components first!

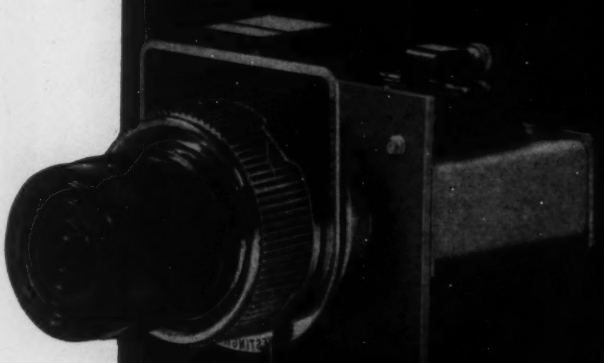
MP-3057-2

YOU CAN BE SURE...IF IT'S Westinghouse

Circle 438 on Page 19



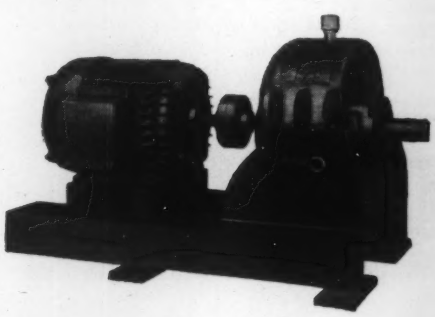
Life-Line® "H" Motors with silicone insulation achieve up to 55 percent reduction in armature inertia by reducing armature size, as shown by the silhouette above. New controlled ventilation system makes this reduction possible. With commutating ability increased 35 percent, the Life-Line "H" assures faster reversing performance.



Push-lite pushbuttons combine the functions of both a pushbutton and indication light in one unit. One push transmits the signal and energizes the indicating light. Push-lites are oiltight — part of the complete Oil-Tite* line of 1,500,000 pushbutton control arrangements available from stock.

*Trade-Mark

Either Westinghouse gearmotors or packaged motor-reducer drives save design time with a wide selection in horsepower, speed ratios, direction of power take-off, mounting and coupling methods. MP-3057-3



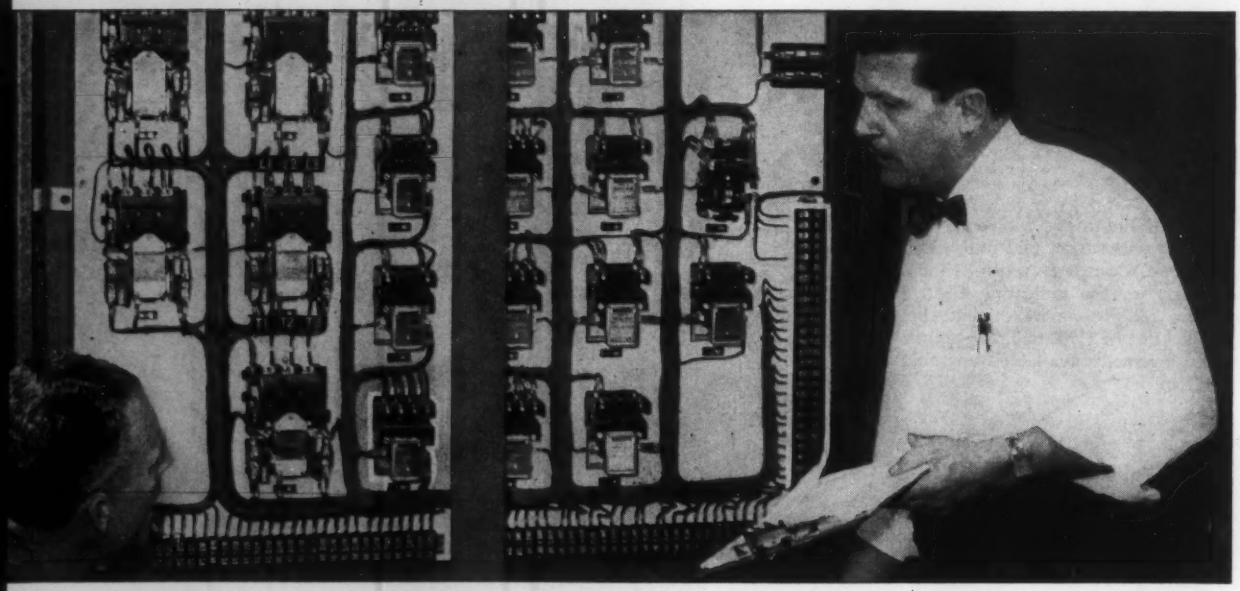
WESTINGHOUSE SERVICES AND FACILITIES ARE FLEXIBLE

HELP YOU FROM DESIGN BOARD TO TEST FLOOR

Add experienced manpower to your machine tool projects by simply calling your local Westinghouse representative. Whether you have a problem in drive system design, in component development or in manufacture and assembly, Westinghouse facilities provide economical ways to get the answer on schedule.

Westinghouse research . . . field engineering service . . . local manufacturing and repair plants . . . renewal parts stocks . . . are all ready to extend you service in any situation.

And when you select Westinghouse components, your customers will recognize electrical leadership. You'll benefit from one-supplier responsibility for products of outstanding quality, backed by more than 70 years of electrical experience. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. MP-3057-4



YOU CAN BE SURE...IF IT'S Westinghouse

Westinghouse serves these O. E. M. industries

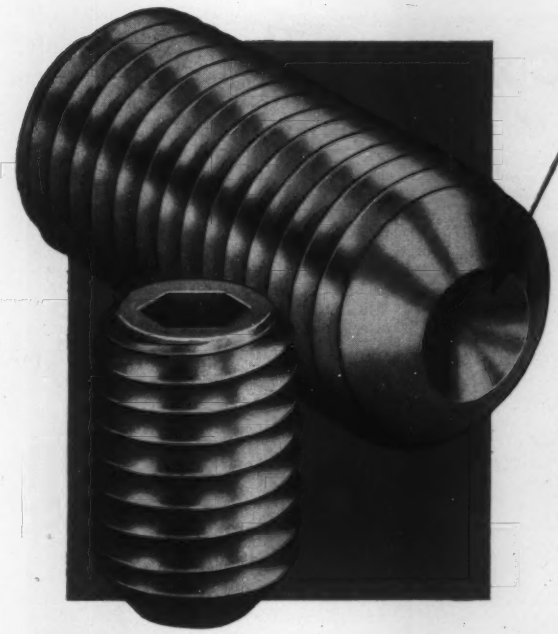
- Air conditioning
- Appliance
- Communications—electronic
- Electric apparatus
- Fan and blower
- Machine tool
- Materials handling
- Panelboard and switchboard
- Prime mover equipment
- Pump and compressor
- Miscellaneous machinery

. . . with these components

- Motors—gearmotors
- Adjustable-speed drives
- Gearing
- Controls—relays—circuit breakers
- Semiconductors
- Cypak*
- Magamp* magnetic amplifiers
- Rectifiers
- Heating elements—thermostats
- Transformers
- Instruments
- DYNAC® magnetic braking

*Trade-Mark

Circle 438 on Page 19



ALLENPOINT will give you a bulldog grip at no premium in price!

Allen's scientific redesign of the cup diameter on set screws gives greatly increased resistance to *withdrawal* torque. You can count on Allenpoint Set Screws to stay tighter longer, under heavy strain and vibrations. This dependable premium performance of Allenpoints is yours to use without increasing the cost of manufacturing your products.

Uniform Class 3A Threads

Allenpoints' smooth, uniform threads prevent off-lead conditions like Fig. 1. With Allenpoints, you have full, even contact between the engaging flanks of the threaded members (Fig. 2) —and a tight friction lock over the entire length of the Allenpoint Set Screw.

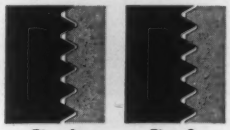


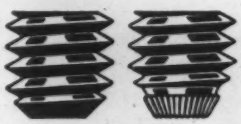
Fig. 1 Fig. 2

Strong, clean, deep sockets allow full wrenching leverage

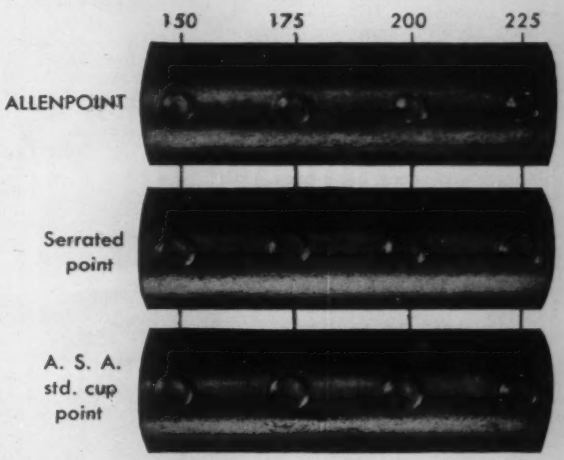
Sockets of Allenpoint Set Screws are cold forged to produce a deeper, smoother socket. No broach chips to interfere with proper seating of the key. This "pressur-forming" preserves the long steel fibers throughout the length of the screw—stronger walls allow maximum tightening torque.

One more full thread on ALLENPOINTS!

Allenpoint Set Screws have one more full thread than serrated point set screws. That means more holding power—especially important when you're using short lengths.



ALLENPOINT's performance compared for you



These actual-size, unretouched photographs show the cup pattern made by Allenpoints, serrated points, and A.S.A. standard cup point set screws in a 3/4" steel shaft. At each degree of tightening force, Allenpoints make a full circle pattern, penetrating deeper for greater holding power.

We'll be glad to send you more information and samples of Allenpoint Set Screws and other Allen Socket Screw products.

Stocked and sold by leading industrial distributors everywhere

ALLEN MANUFACTURING COMPANY
Hartford 2, Connecticut, U.S.A.

ALLEN HEX-SOCKET SCREWS HEAD

Fastener Facts

by Henry Peterson, Chief Engineer — Judson L. Thomson Mfg. Co.

DESIGN PRODUCTION & PURCHASING DATA

USE OF BIFURCATED (SPLIT) RIVETS

Self-Piercing Fasteners

You specify bifurcated (split) rivets when you want self-piercing, permanent fasteners for high-speed assembly of light metals (up to 0.040" thick), wood, fibre, leather, canvas and plastics.

Slots milled in the bodies of cold-headed solid rivets form two prongs that have the inherent strength of forgings.

Advantages of Use:

With bifurcated rivets, you not only eliminate the delay and cost of pre-punching or pre-drilling holes, but also avoid weakening assemblies through removal of material. Applied by high-speed automatic rivet-setting machines, which can be operated by unskilled help, they reduce assembly time and costs to a minimum.

When you specify Thomson Bifurcated Rivets, you make sure of the fastest possible solution to your fastening problem and earliest possible delivery of test samples and production quantities.

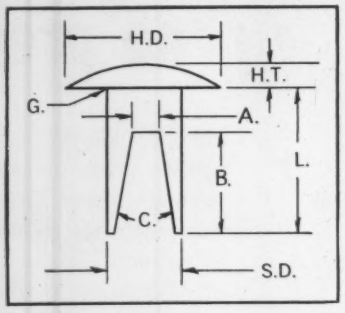
As the first patent holder on bifurcated rivets, Thomson has the longest experience in applying them. Since 1885, thousands of standards have been developed for manufacturers of canvas bags, dog collars and harnesses, golf bags and shoes, hand bags, leather goods, luggage, raincoats, sheet metal products and assemblies, sporting goods, tote boxes, and other products. So your chances of solving special problems with standard bifurcated rivets are best when you call on Thomson.

DIMENSIONAL DATA:

Head Diameter (H.D.) ranges between 1.75 and 2.75 times shank diameter for rivets produced by single-die heading machines. Larger diameters are available at higher cost.

Head Thickness (H.T.) ranges from 0.3 to 0.6 times shank diameter depending on head shape: oval, flat countersunk, ideal, flat, countersunk with bevel on bottom.

Shank Diameter (S.D.) ranges from .040" to .330" for standard sizes.

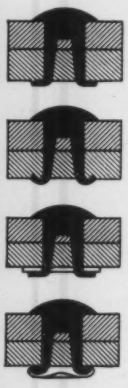


Slot Width (A.), Slot Depth (B.) and **Slot Angle (C.)** vary with each application, depending on thickness and hardness of materials and strength requirements of the clinch. Tests on actual samples are recommended in most cases.

Rivet Length (L.) ranges from 0.6 to 6 times shank diameter. Exact length is generally determined by adding shank diameter to assembly thickness.

Radius (G.) at corners ranges from .005" for ¼" rivets to .015" for 2" rivets.

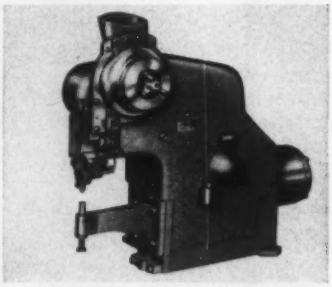
Four Types of Clinch:



Thomson Bifurcated Rivets are clinched by anvils that spread the prongs flush with the surface, turn their prongs into material, against burrs (washers) or inside caps. The latter two methods are specified when a stronger bearing surface is required. The use of caps improves assembly appearance by giving uniform appearance to both ends of the rivets. Washers and caps are applied by multiple-feed automatic rivet-setting machines. The use of caps, calls for perfectly symmetrical rivets so that neither prong will miss the cap. Thomson guards against such misses by precision manufacturing, statistical quality control, 100% final inspection and factory tests on actual samples.

High-Speed Rivet-Setting Machines

Whatever your fastening job, the chances are that one of Thomson's more than 200 standard rivet-setting machines can be quickly and easily adapted to fit your needs. Models include combination rivet and cap-setting in both bench- and floor-types with 5" throat depth. Automatic hopper feed, multiple rivet-setting heads and special work-handling and loading devices are accessories that speed up assembly. Thomson helps you select the proper machine for your job, custom-tools it to meet your requirements and factory-tests it on actual samples before shipment. Available on a sale or lease basis.



MOTOR-OPERATED BENCH MACHINE

Design and Engineering Service

Save time and money by asking Thomson Engineers to study your fastening problems before your designs are frozen. This service, performed at your request, promises the speediest delivery of the right rivets and machines for you. Send sketches, prints, or actual samples for recommendations and quotations.

Free "Fastener Fact File".

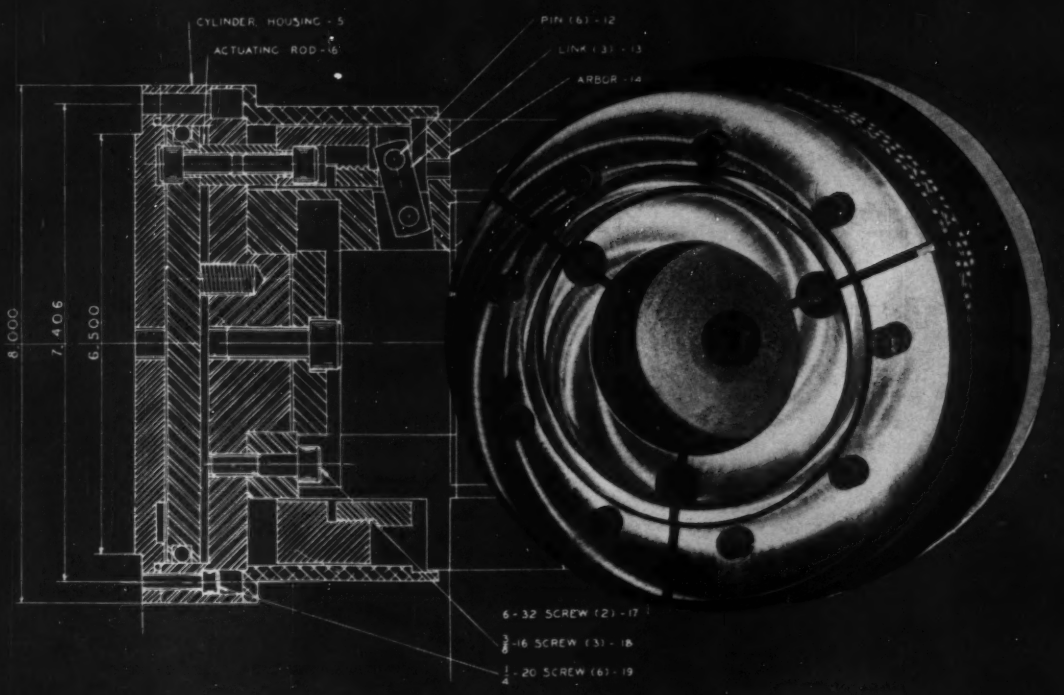
This new Thomson manual is compulsory reading for anybody who specifies or buys fasteners. It covers everything you need to know to take advantage of the economy and speed of rivets and rivet-setting machines: rivet types, applications, material finishes and other vital factors.

Request your copy today. Write Judson L. Thomson Mfg. Co., Dept. D, Waltham 54, Massachusetts.

JUDSON L. THOMSON MFG. CO., WALTHAM 54, MASS.

Circle 440 on Page 19

Arbors, links, jaws, and often the air cylinders of these Stace-Allen precision air chucks are made of Crucible MAX-EL. Manufacturer: Stace-Allen Chuck Company, Indianapolis, Ind.



nondeforming, easy-machining MAX-EL alloy steel chosen for precision chuck parts

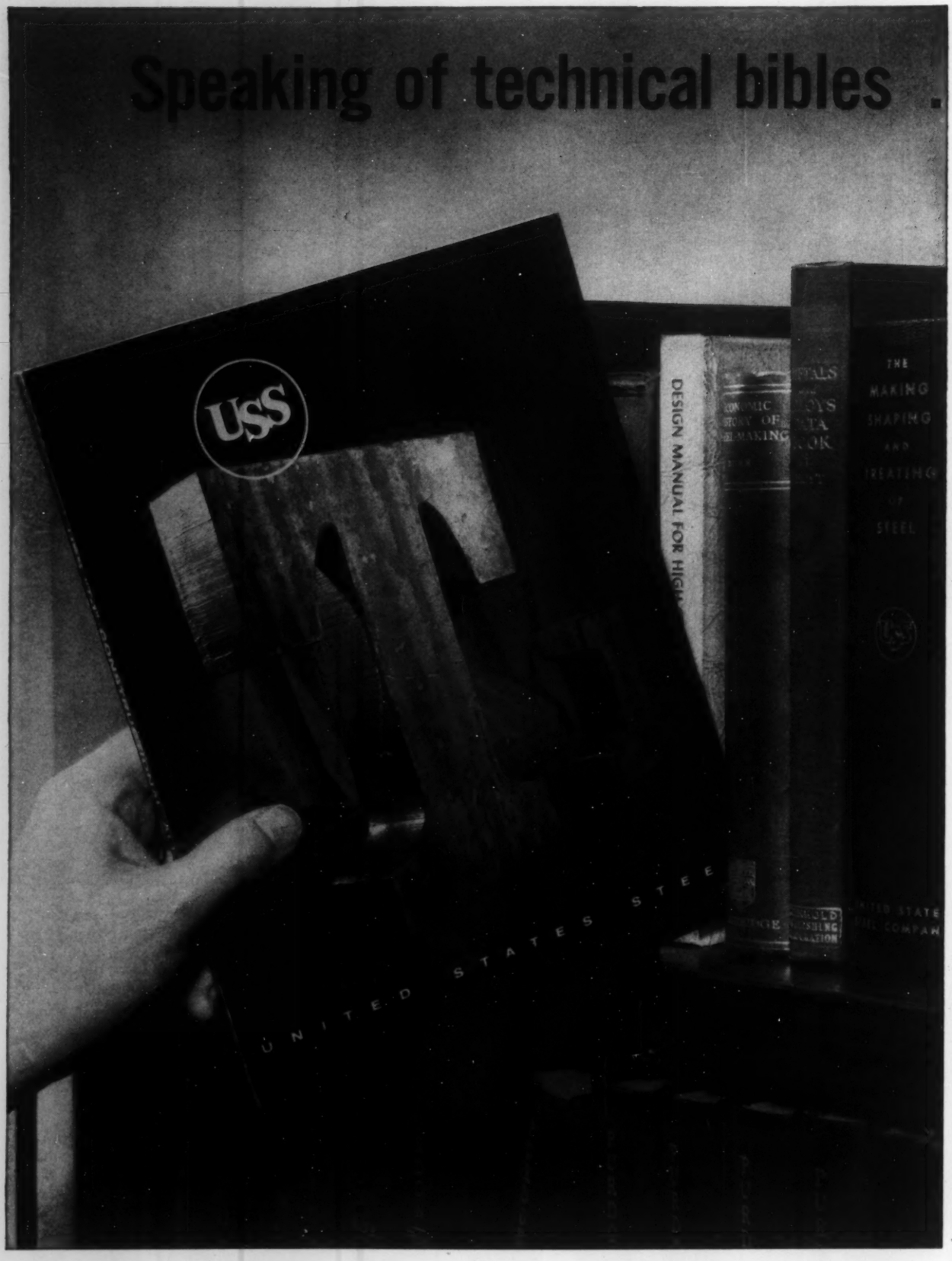
Several components of Stace-Allen precision air chucks, which are made of Crucible MAX-EL® alloy steel, are finish machined *after full heat treatment.* This can be done because MAX-EL machines easily, even at hardnesses as high as 352 Brinell—or higher, with special tooling.

Other components, on the other hand, are machined, then heat treated. MAX-EL is used here because Stace-Allen finds there is minimum distortion in these parts after hardening.

But try MAX-EL for yourself. Whether your production schedule calls for machining-then-hardening—or the other way around—you'll find easy-machining, nondeforming MAX-EL a natural selection. Call your local Crucible warehouse for quick delivery of MAX-EL in the grade or size you need. And for more MAX-EL facts, write us for a free Data Sheet. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America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USS
DESIGN MANUAL FOR
THE MAKING SHAPING AND TREATING OF STEEL
UNITED STATES STEEL

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Without this excellent book,
your technical library isn't complete.
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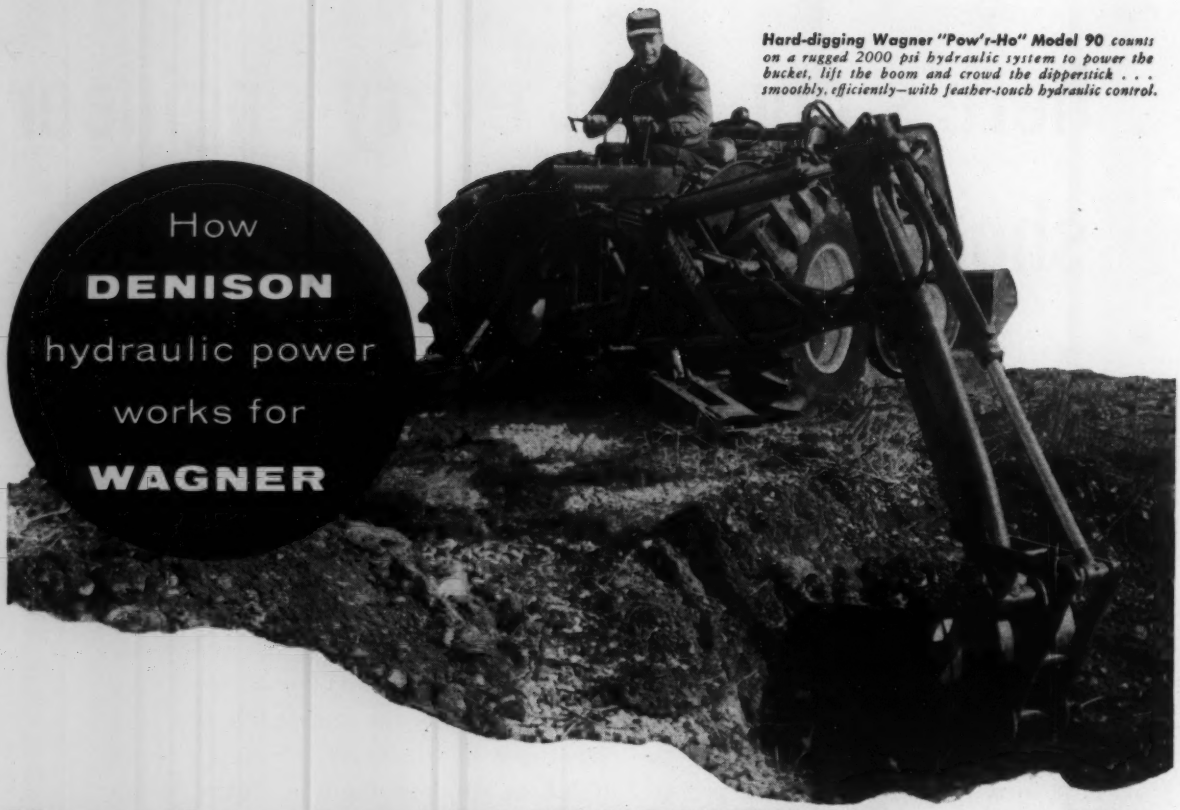
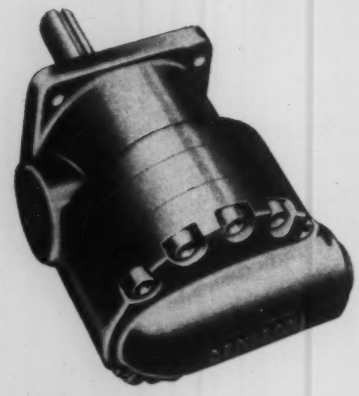


Hard-digging Wagner "Pow'r-Ho" Model 90 *counts on a rugged 2000 psi hydraulic system to power the bucket, lift the boom and crowd the dipperstick . . . smoothly, efficiently—with feather-touch hydraulic control.*

How **DENISON** hydraulic power works for **WAGNER**

How the rugged WAGNER "Pow'r-Ho" bites 12-feet deep

. . . another application for DENISON hydraulic power



Hydraulic Punch *for the "Pow'r-Ho" is supplied by a single Denison 2000 psi TMC balanced-vane pump that actuates five hydraulic cylinders.*

Whatever the job—digging gas line . . . foundations . . . or drainage ditches—the rugged Wagner "Pow'r-Ho" Model 90 backhoe bites in hard, fast and deep with hydraulic muscle-power by Denison.

Five hydraulic cylinders—actuated by a Denison hydraulically-balanced TMC vane-type pump—power the bucket . . . lift and swing the boom . . . crowd the dipperstick. It's a fast, smooth, efficient operation—with power to spare, because a rugged, Wagner-designed 2000 psi hydraulic system and the Denison TMC vane pump make it that way.

Result: Harder digging with faster time cycles that mean *more profit* to the user.

It's the kind of job your Denison hydraulic specialist can help *you* do. Ask him more about how Denison 2000 psi pumps can improve the performance of *your* equipment. Write Denison Engineering Division, American Brake Shoe Co., 1240 Dublin Road, Columbus 16, Ohio.

DESIGNERS—ENGINEERS! Write for your copy of Bulletin 201—"How to Design More Efficient Hydraulic Power Into Mobile Machinery".

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HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

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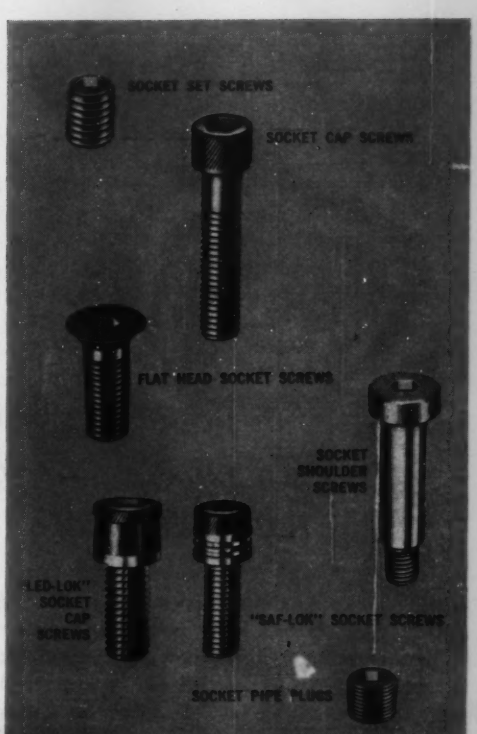
Circle 443 on Page 19

ALL OVER THE MAP!

No matter where you are, you're never very far from convenient warehouse stocks of Blue Devil Socket Screw Products. Next to quality, we feel, is service . . . getting you the sockets you need *when* you need them. When you place an order with a Blue Devil distributor, you can be sure he'll be able to make delivery from his stock or our nearest warehouse, on time and in any quantity. Next time, try Blue Devil . . . you'll be delighted!

Actual cross-section diagram shows how cold forming of Blue Devil Socket head insures unimpaired fiber continuity.



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WAREHOUSE LOCATIONS: San Francisco, 52 Zoe Street
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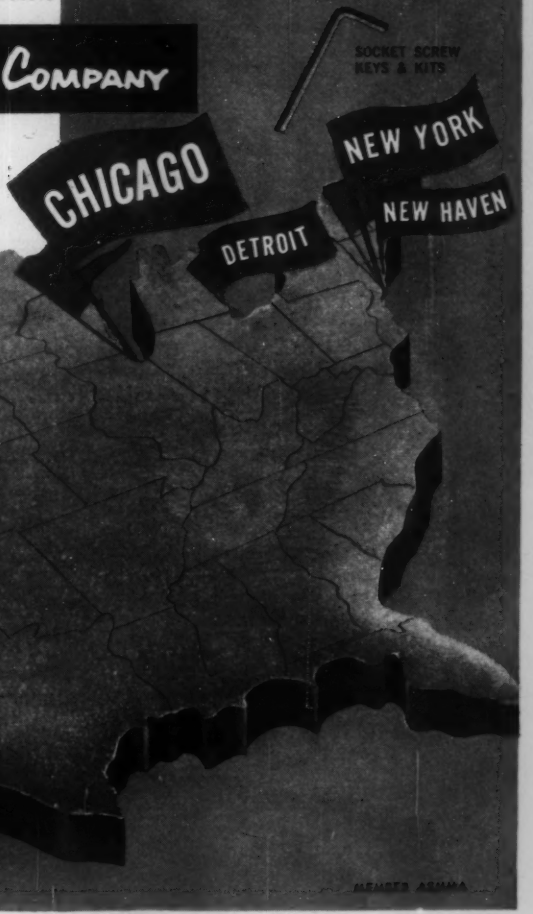
SOCKET SCREWS EXCLUSIVELY!



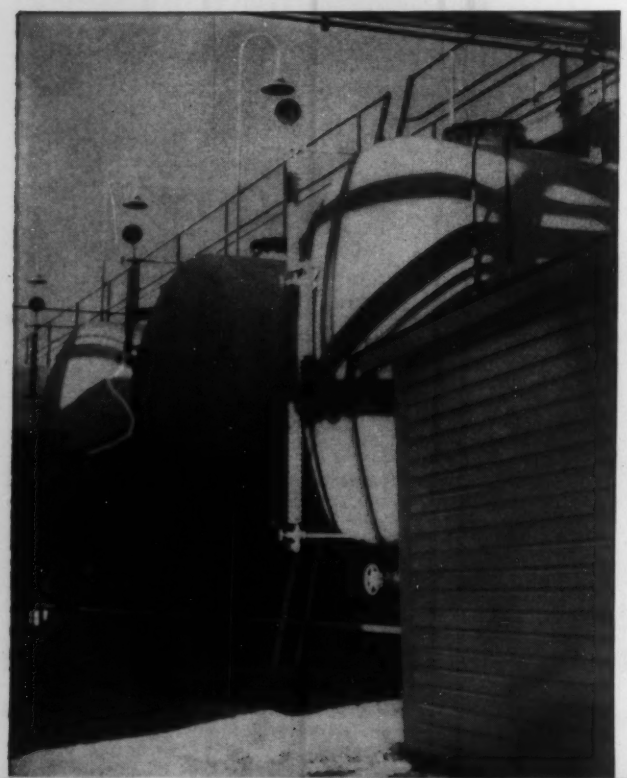
Designing with BAKELITE BRAND Plastics

- *Coating protecting tanks for 3 years*
- *Rugged plastic part for carburetor air cleaner*
- *Plastic credit cards that print*

Keep informed about plastics and you'll find them a source of new design ideas. Besides the great variety of plastics already available, new products are constantly appearing. One of them may have exactly the set of properties you have been looking for, and at a considerable saving.

Keep in touch with Bakelite Company. It is your best source of information because it is a leading source of plastics. You can select from the widest variety of materials in the field—phenolics, vinyls, styrenes, impact styrenes, polyethylenes, epoxies, and silicones. And you can call on the laboratory services and technical resources of Bakelite Company for aid in working them into your plans.

1 Vinyl-based coating protects ammonia tanks three times longer



Service conditions surrounding these tanks proved too severe for two earlier coating systems — one failed in eight months, the other in a year. Measuring 10′ 6″ in diameter and 53′ long, the tanks hold caustic solution, and are located in a plant manufacturing 45 million lbs. of petrol-cracking catalyst annually. Vapors in the area contain sulfate salts and intermittent sulfuric acid spray.

Three years ago, a coating system made by Amercoat Corp. based on BAKELITE Brand Vinyl Resins was applied to the exterior of these tanks. It has remained in excellent condition. The first coat was worked into the bare metal by brush to obtain good adhesion. Three subsequent coats were applied by spray. Each was a different color to insure complete coverage. Total thickness was six to eight mils. Maintenance has been at a minimum.

A variety of coatings are formulated from BAKELITE Vinyl Resins and used widely in both industrial and consumer applications. For a complete description of these materials, write Dept. AV-103.

2 C-11 Plastic pre-cleaner withstands engine oil, heat, dirt

More than 75 percent of the dirt that would normally enter the oil-washed air cleaner on tractor engines is removed by this collector pre-cleaner made by Minnesota Plastics Corporation for Donaldson Company, Inc., St. Paul, Minn. It is also designed to serve as an air stack cap, preventing leaves, twigs, and chaff from entering, and forms a rain shield that keeps water out of the center tube intake. Molded of BAKELITE Brand C-11 Plastic, this collector pre-cleaner has a high heat distortion point, and stands up under the working temperatures generated by tractor engines. Since C-11 Plastic is transparent, the pre-cleaner shows when it has collected excess dirt, and is readily removed and washed.

BAKELITE C-11 Plastic is an acrylonitrile-styrene copolymer. It has good resistance to impact and exceptional resistance to chemicals, including foods. It offers a wide choice of color, and molds to a smooth, glossy finish. These properties have led to the wide use of C-11 in packaging as well as for machine parts like this collector pre-cleaner. For more details on C-11 Plastic, write Dept. AW-103.

3 Credit card, charge plate, and ad on one vinyl rigid sheet

This wallet-sized plastic card can tell you a lot about the design features of BAKELITE Brand Rigid Vinyl Sheets. The color printing, in perfect register, makes it an effective ad and proves its dimensional stability. The three-dimensional lettering shows how well these sheets can be formed to fine details. And toughness is demonstrated in the card's ability to stamp its imprint on invoices, as well as to take frequent handling without damage.

BAKELITE Rigid Vinyl Sheets come in several stock sizes and finishes, and a variety of colors, as well as clear transparent, translucent, or opaque. They can be formed into three-dimensional shapes to fill a wide range of design requirements. To learn more about them, write Dept. AX-103.

TYPICAL PROPERTIES OF "BAKELITE" RIGID VINYL SHEETS

Heat distortion temp. at 264 psi. Fiber stress, deg. C. (D648-45T)	64 avg.
Flammability (D568-43)	self-extinguishing
Tensile strength, psi (D638-49T)	7700 avg.
Flexural strength, psi (D790-49T)	12,600 avg.
Modulus of elasticity in flexure, psi (D790-49T)	430,000 avg.
Impact resistance (impactometer method) ft./sec. (WC-68-C-1/1) (corrected to .010 inch)	55 avg.
Specific gravity, 23/23 deg. C. (WC-1-M/1)	1.45 avg.
Dielectric strength (0.100 in. specimen) volts/mil Short time test in oil (D149-55T)	425 avg.
Volume resistivity, ohm-cm. (D257-54T)	10^{16} avg.

THERE'S MORE TO DESIGN WITH IN

BAKELITE

BRAND

PLASTICS

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Circle 445 on Page 19

Seeburg designers choose P-K screws

to match the fastener to the job!

Joseph Kamys, engineer, J. P. Seeburg Corporation, Chicago, manufacturers of coin operated phonographs says, "Seeburg standards demand attention to every detail—quality workmanship and materials throughout. With Parker-Kalon screws, we can match the fastener to the specific application—be sure of dependable results."

Attachment of metal base molding and kickplate to a Seeburg cabinet, in a metal-to-wood application. "Rather than use ordinary wood screws, we power-drive P-K Self-tapping Type-A," says Mr. Kamys. "Holding power is far better, there's less chance of wood splitting, and fewer rejects at inspection."

Here, metal rims of two high-frequency speakers are fastened to a formed, one-piece, plastic housing. "In this metal-to-plastic application we have not only the problem of possible plastic breakage, but the fastener used must be highly resistant to vibration. We find P-K thread-forming Type-Z screws highly satisfactory."

If you are designing a new product or new model, it will pay you to talk with a Parker-Kalon Field Engineer. He can help in the selection of proper fasteners, can often suggest ways to speed production—cut costs. You can contact him through your local Parker-Kalon Industrial Supply Distributor.

***PARKER-KALON DIVISION,** General American Transportation Corporation, Manufacturers of Self-tapping Screws, Socket Screws, Screwnails, Masonry Nails, Wing Nuts and Thumb Screws.*

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PARKER-KALON®
fasteners

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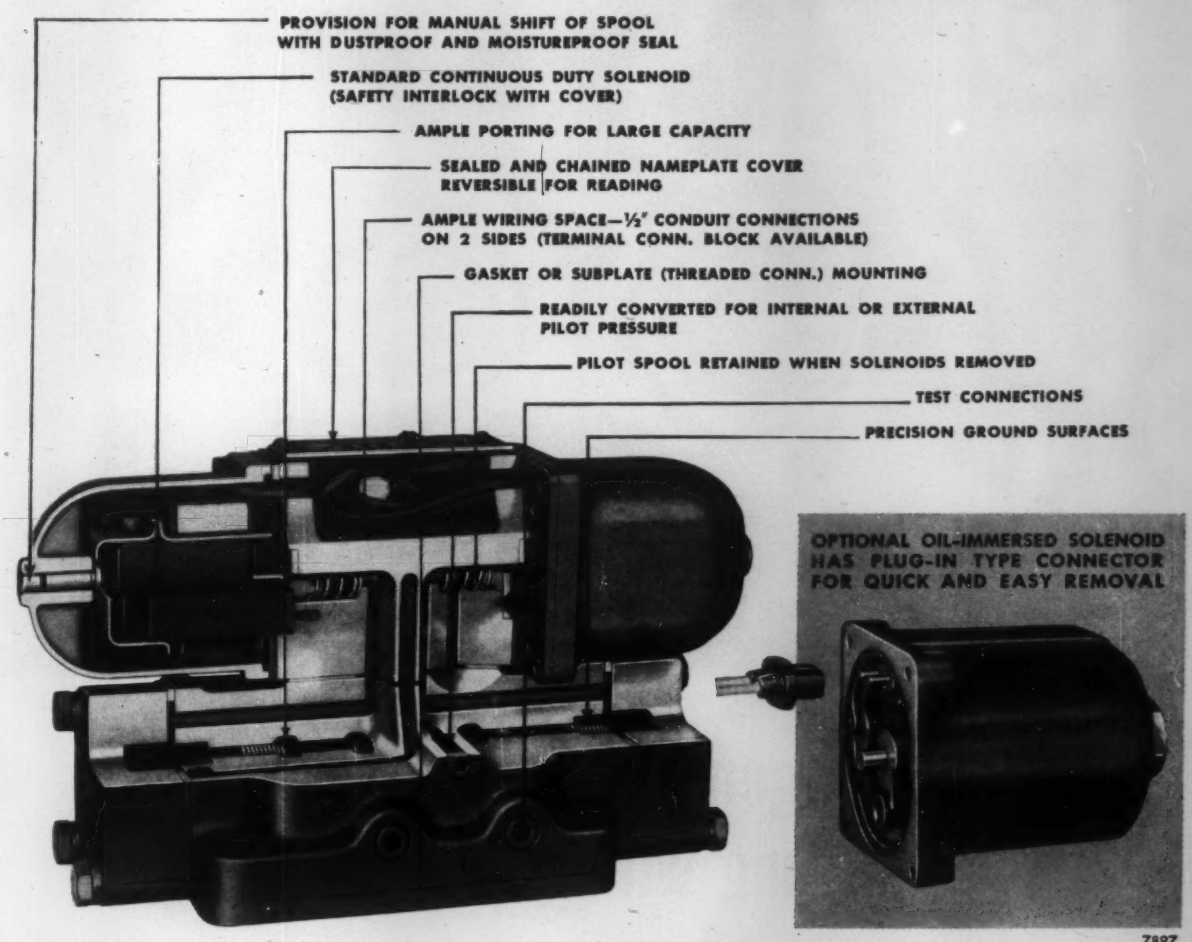
PROVISION FOR MANUAL SHIFT OF SPOOL WITH DUSTPROOF AND MOISTUREPROOF SEAL
STANDARD CONTINUOUS DUTY SOLENOID (SAFETY INTERLOCK WITH COVER)
AMPLE PORTING FOR LARGE CAPACITY
SEALED AND CHAINED NAMEPLATE COVER REVERSIBLE FOR READING
AMPLE WIRING SPACE—½" CONDUIT CONNECTIONS ON 2 SIDES (TERMINAL CONN. BLOCK AVAILABLE)
GASKET OR SUBPLATE (THREADED CONN.) MOUNTING
READILY CONVERTED FOR INTERNAL OR EXTERNAL PILOT PRESSURE
PILOT SPOOL RETAINED WHEN SOLENOIDS REMOVED
TEST CONNECTIONS
PRECISION GROUND SURFACES
OPTIONAL OIL-IMMERSED SOLENOID HAS PLUG-IN TYPE CONNECTOR FOR QUICK AND EASY REMOVAL
7897

REDUCED DOWN-TIME
LONGER SOLENOID LIFE
LESS MAINTENANCE
EASIER INSTALLATION

Vickers hydraulic 2- and 4-way valves provide the optimum in directional control. They are compact, versatile, and are designed for heavy duty, continuous and rapid cycling operation on all types of industrial machinery. More than a decade of application experience and years of research and development back all the valves' features.

Seven spool types satisfy a wide variety of circuit needs and operate at pressures to 3000 psi. Optional oil-immersed solenoids operate cooler, increasing service life 20 to 30 times.

Installation is simplified with ease of wiring and a minimum of piping. The valves are available for gasket or sub-plate mounting. Mounting position is unrestricted except in "no-spring" models. The optional oil-immersed solenoid has a plug-in type connector and is available in all standard voltages. Field modification of existing units can be made to incorporate heavy-duty, oil-immersed solenoids.

The valves conform to JIC Standards and are available in ⅛" and ¼" direct solenoid operated models . . . ¾", 1¼", 2", and 3" solenoid controlled pilot operated models. These valves cover the flow range from 1.25 gpm to 320 gpm.

For further information, write for Installation Drawing I-182412.

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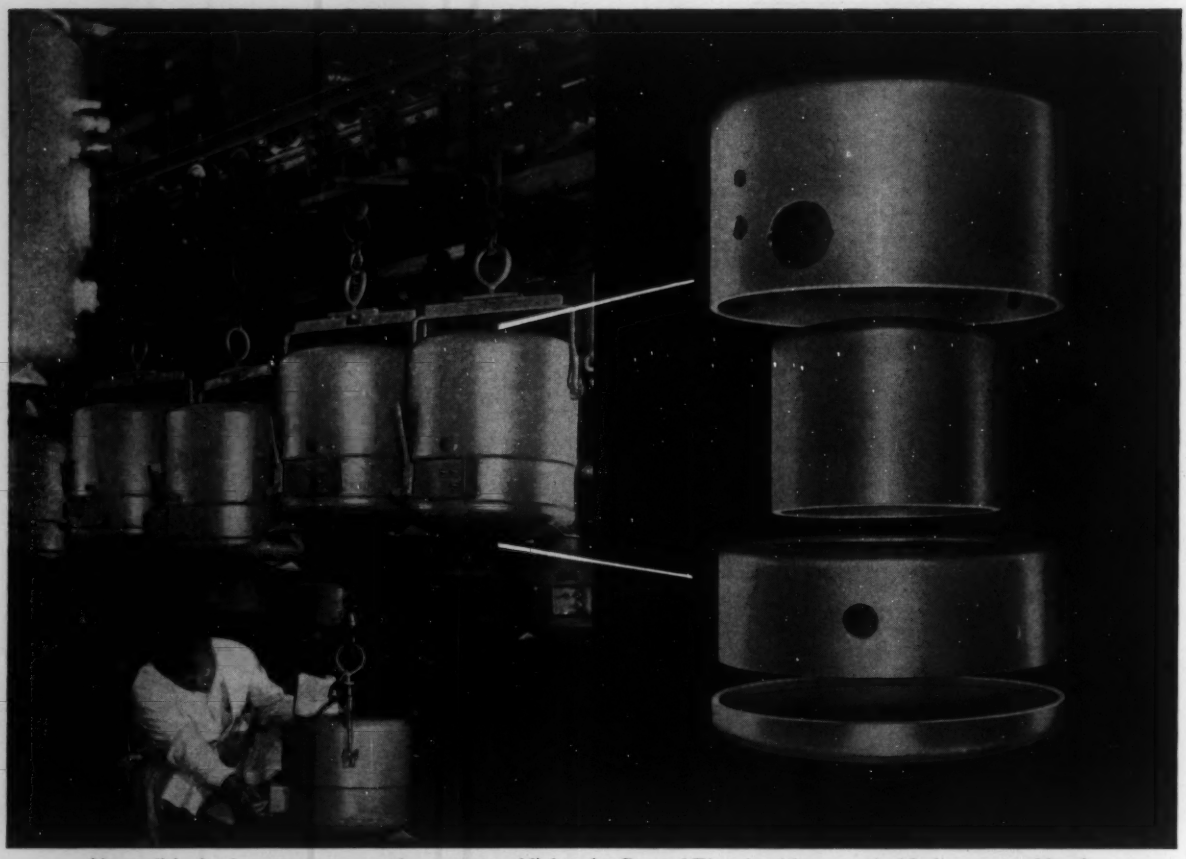


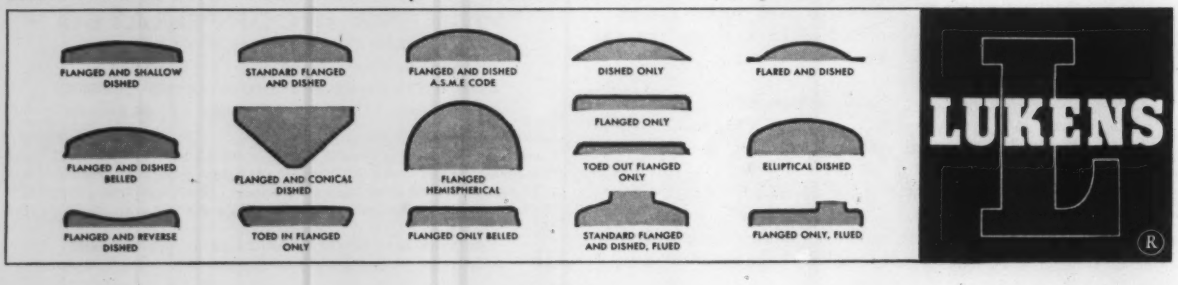
Air conditioning heat pumps are made stronger and lighter by General Electric with economical Lukens pressed heads.

Ingenuity pays off... designing with Lukens heads

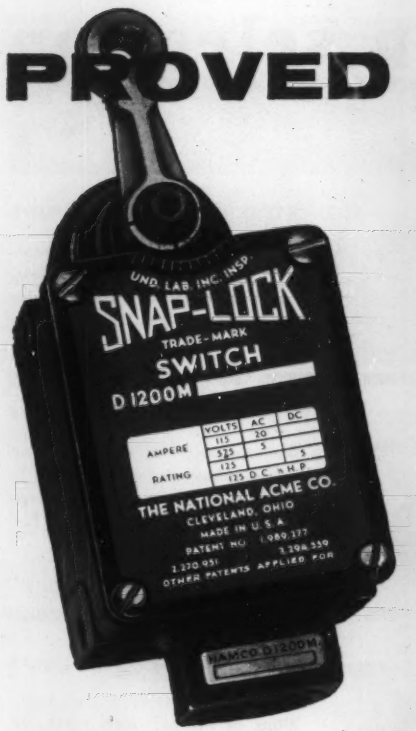
■ Ingenuity ... and four Lukens heads ... meant considerable savings and increased strength in these General Electric Weathertron heat pumps. Designers at General Electric's Air Conditioning Division, Bloomfield, N. J., eliminated the need for expensive castings by making the pump compressor housings of Lukens heads, pressed to extremely fine tolerances. Fitted together they result in stronger and lighter units.

Whether you make heavy or light machinery, valves, wheels, or pumps, Lukens heads may be the answer to a costly fabrication problem. Designers have been using them for years. Lukens' fifty-five years as the leading producer of spun and pressed heads for many applications are at your service. Write today for Catalog 933, *"Pricing and Engineering Data,"* Lukens Steel Company, Coatesville, Pennsylvania.

Lukens Offers the World's Broadest Line of Spun and Pressed Heads of Carbon, Alloy and Clad Steels



PROVED . . . by millions of contacts



NATIONAL ACME

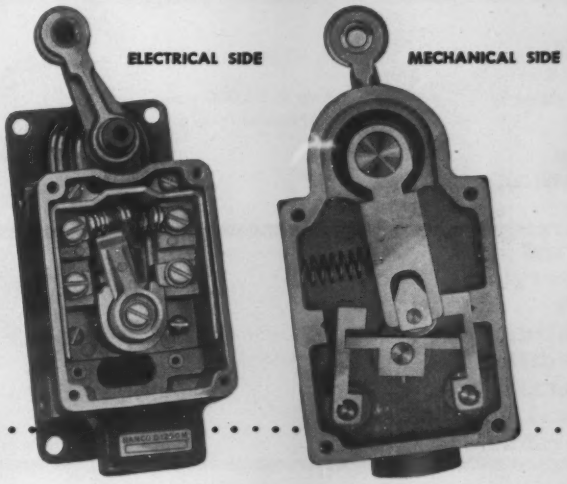
SNAP-LOCK

TRADE MARK

As illustrated below, National Acme SNAP-LOCK Limit Switches employ a basically simple yet positive *snap-action* locking mechanism—with extremely few moving parts. Thus wear is reduced to a minimum and dependable trouble-free service. far beyond normal limits, is assured.

The double-throw contact lever, connected directly by shaft with the latch bar, carries self-wiping coin silver contact points to assure quick action make or break—reducing wear ever further.

Electrical and mechanical sides are separated by a wall within a sturdy die-cast housing which is fully insulated and is dust and oil-tight.



THE ORIGINAL SNAP-ACTION LOCKING SWITCH

SNAP-LOCK LIMIT SWITCHES. Made in single-pole and double-pole series, in four types: Standard, Short Travel, Neutral Position and Push Lever. With the exception of the Push Lever Switch, all are adaptable to special enclosures for hazardous location service and may be used with various styles of operating levers. For AC or DC service.

and now . . .

a new design concept for **CONTROL STATION SWITCHES**

the heavy-duty . . . oil, water, dust tight **GOLD-N-RING**

made by machine tool builders to machine tool specifications

Heavy duty silver-alloy contact points provide maximum electrical capacity, long life.

Heavy duty terminal screws have ⅛" thread contact to prevent stripping during installation and permanently secure wires for continuous, trouble-free service.

Single or double-pole contact block assemblies—can be used interchangeably with several types of GOLD-N-RING push button and selector operator heads.

Rated for 600 volts—AC or DC. Meets all Joint Industry Committee and National Machine Tool Builder's Association requirements.

Protected against oil and water seepage in operator head by Sealtight oil-resistant rubber diaphragm.

Easily replaces existing switches.

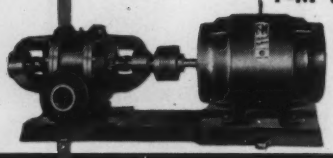
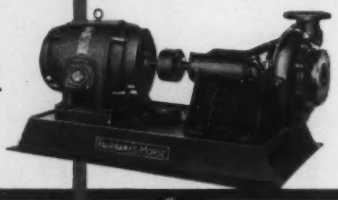
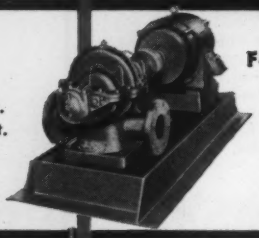
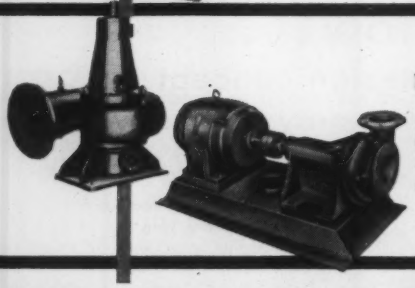
ELECTRICAL MANUFACTURING DIVISION

the National Acme company

188 EAST 131st STREET, CLEVELAND 8, OHIO

Circle 449 on Page 19

Guide to better pump selection

for		specify
boiler feed condensate return hot and cold liquids chemicals refrigerants, etc.	up to 200 gpm. pressures to 900 ft.	 **F-M WESTCO PERIPHERAL PUMPS** High pressure at normal operating speeds. Handle widely varying heads with little change in capacity. Sizes 1¼" through 2½".
hot and cold liquids liquid circulation nonviscous liquids boiler feed cooling towers, etc.	up to 900 gpm. pressures to 525 ft.	**F-M BUILTOGETHER CENTRIFUGAL PUMPS** General-purpose, close-coupled pump and motor units mount in any position—horizontal, vertical or angular. Sizes ¾" through 5".
sewage slurries paper stock fruit shrimp vegetables, etc.	up to 30,000 gpm. pressures to 175 ft.	 **F-M NON-CLOG PUMPS** Unexcelled for clog-free handling of liquids with solids in suspension. Sizes 2" through 20". Vertical or horizontal. Bladeless or conventional.
water supply plant service booster circulating air conditioning refrigeration chemical liquids boiler feeds, etc.	up to 50,000 gpm. pressures to 700 ft.	 **F-M SPLIT-CASE CENTRIFUGAL PUMPS** High, sustained efficiency over wide range of conditions. Low-cost maintenance. Sizes 1½" through 36". Single stage or multistage.
hot and cold liquids chemicals circulating liquids nonviscous liquids cooling towers condenser circulation, etc.	up to 100,000 gpm. pressures to 250 ft.	 **F-M END-SUCTION PUMPS** A wide line of rugged, precision-built pumps. Sizes ¾" through 54". Horizontal or vertical centrifugal.

FOR LOW-COST PUMPING *SPECIFY* FAIRBANKS-MORSE

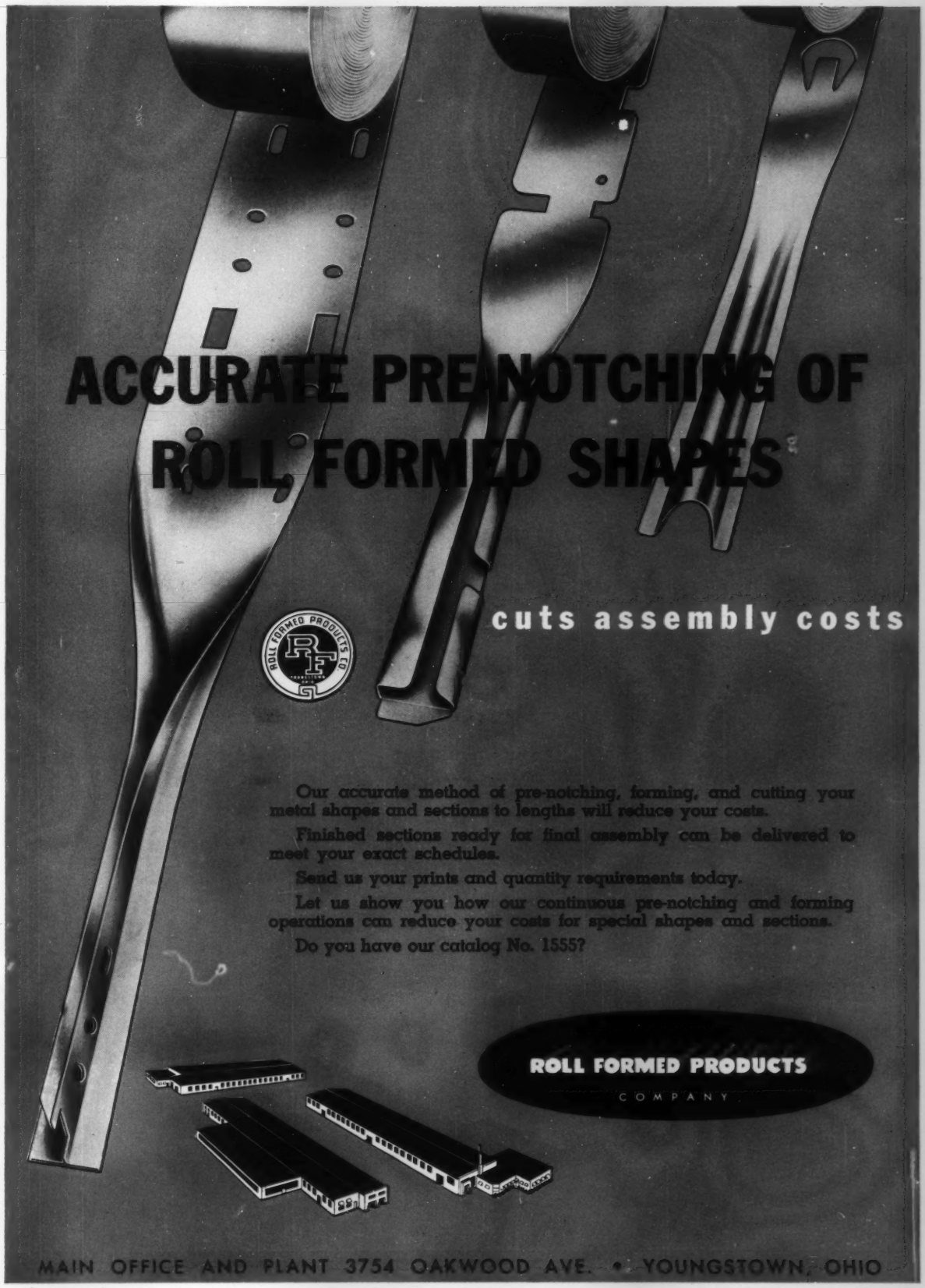
Need new pumps? Your Fairbanks-Morse Dealer has the world's greatest variety for you to choose from. Need help in selection? Your F-M Dealer and F-M Sales Engineer will help specify the right type, right size pump and driver for low-cost, foolproof operation. Call them today, or write Fairbanks-Morse & Co., Dept. MD-11-14, 600 So. Michigan Ave., Chicago 5, Illinois.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS

Circle 450 on Page 19


ACCURATE PRENOTCHING OF
ROLL FORMED SHAPES
cuts assembly costs
ROLL FORMED PRODUCTS CO
Our accurate method of pre-notching, forming, and cutting your metal shapes and sections to lengths will reduce your costs.
Finished sections ready for final assembly can be delivered to meet your exact schedules.
Send us your prints and quantity requirements today.
Let us show you how our continuous pre-notching and forming operations can reduce your costs for special shapes and sections.
Do you have our catalog No. 1555?
ROLL FORMED PRODUCTS
COMPANY
MAIN OFFICE AND PLANT 3754 OAKWOOD AVE. • YOUNGSTOWN, OHIO

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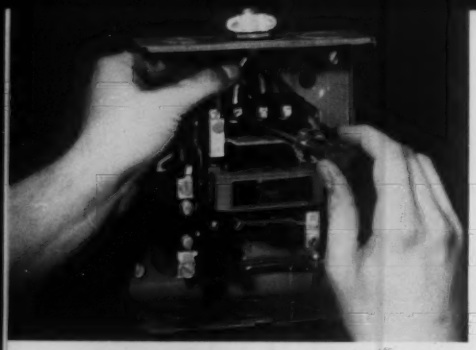
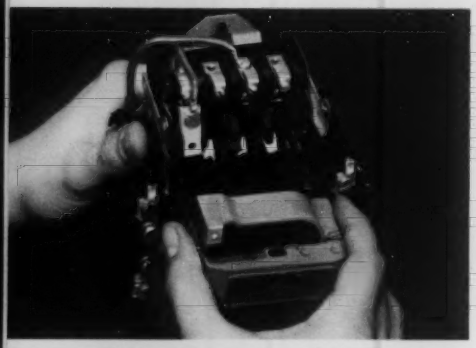
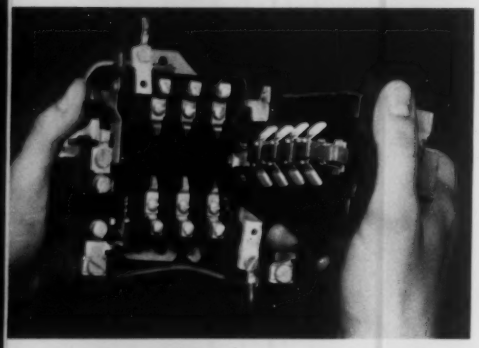
Circle 452 on Page 19→



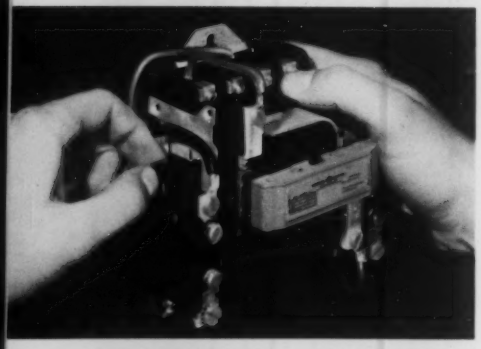
NEW **GREATER WIRING SPACE**
Wrap-around cover—removable enclosure sides make wiring much easier.



NEW **SNAP-SLIDE CONSTRUCTION**
Principal components quickly disassembled for easier inspection and maintenance



NEW **"VERTICAL" CONTACTS**
Continuous dependable operation of new starter—even in dusty atmospheres



NEW **ADJUSTABLE OVERLOADS**
Overload trip setting can be adjusted plus or minus 15% of nominal heater rating.

General Electric announces

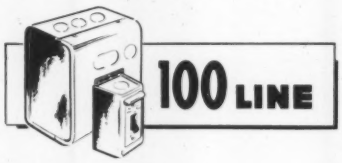
NEW Size 0 and 1 Magnetic Starters—42% Smaller in Size

General Electric now offers a new line of Size 0 and 1 magnetic starters that is 42% smaller than previous open forms and is built to the new NEMA ratings. The new starters with "snap-slide" construction provide easier inspection and maintenance because principal components snap or slide together. Completely new and radically different in design, this line of starters offers:

- wrap-around cover with spring latch—easily removed without tools for inspection
- removable sides for greater accessibility
- straight-through wiring speeds installation
- pressure-type terminals make wiring easy
- vertically-slanted contacts give higher tip pressure, reduce possibility of contact welding
- long life "kick-off" spring provides clean break of contacts in any mounting position
- strongbox coil with Mylar* insulated start wire for longer coil life
- overload relays adjustable for ±15% of trip setting
- nine field modification kits for greater flexibility
- new maximum NEMA ratings up to 7½ hp at 220 volts and 10 hp at 440 volts

Two additional features of the new magnetic starter are extremely quiet operation and lower inrush requirements of the coil. Sound absorbing material around the magnet lowers the operating noise level. Lower coil inrush current will allow you to use a 47% lower rated control transformer with this starter—saving you money and mounting space.

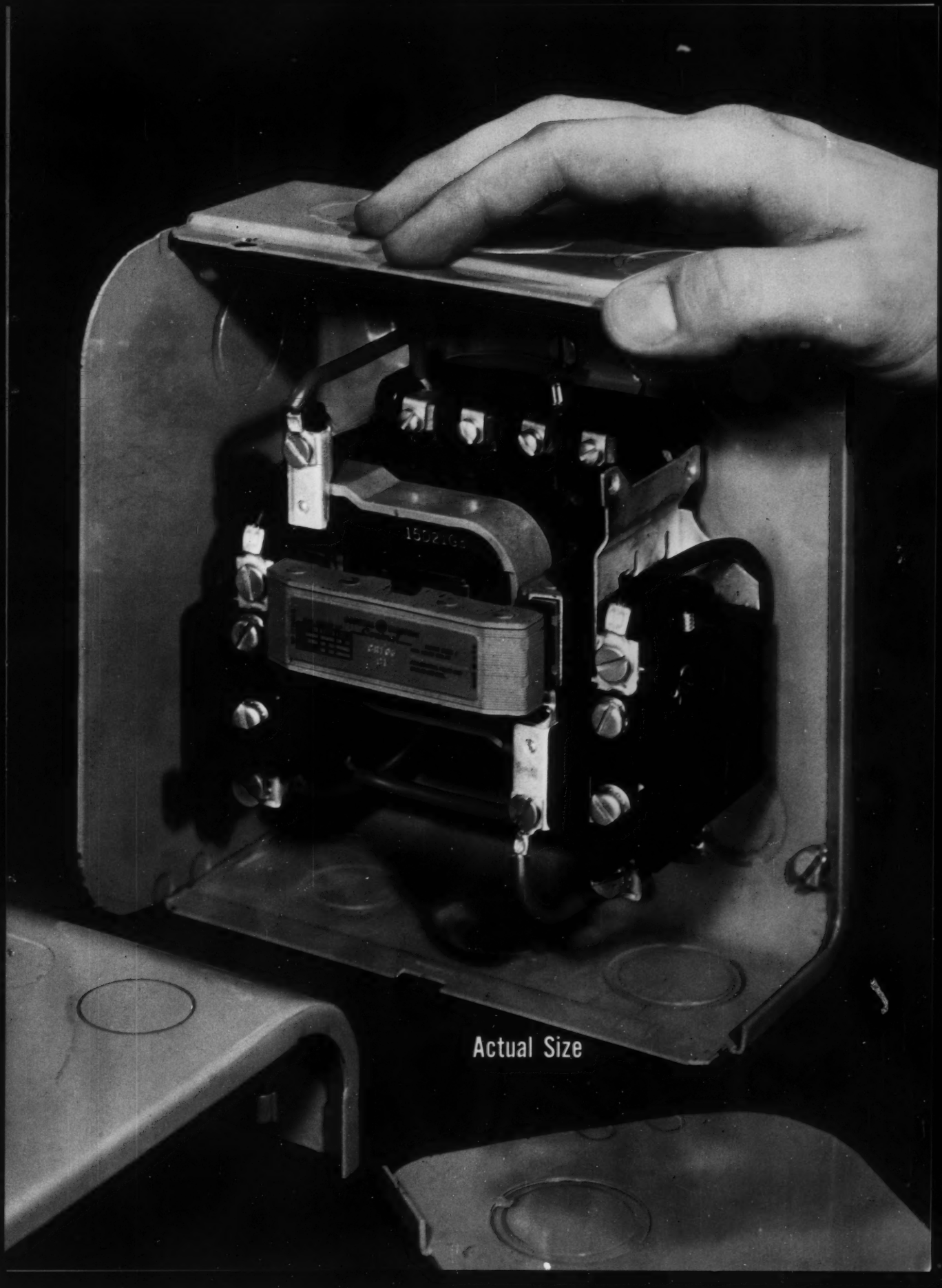
Size 0 and 1 General Electric starters are available now in non-reversing, combination, reversing and multispeed forms. Contact your nearest General Electric Sales Office or Distributor, or write Advertising Section 731-13 for the 20-page bulletin describing the line. Ask for GEA-6611. General Electric Company, Bloomington, Illinois.



*Trade-mark of DuPont Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC



Actual Size

MECHANICAL ENGINEERS
ELECTRICAL ENGINEERS

Challenging job opportunity on the editorial staff of

MACHINE DESIGN

Here's your chance to break in on a growing field where aggressive creative work is really appreciated. MACHINE DESIGN has a staff opening for an engineer with an interest in both engineering and editorial work. This job provides stimulating contact with many engineering areas plus opportunity to grow and progress as a specialist in a particular branch of design engineering.

Some evidence of design engineering experience is necessary, and an ME or EE degree would be desirable. Writing ability and interest are also required, although a heavy background of editing or writing is not essential.

Salary will depend on experience; progress for the right man can be rapid. Headquarters are in Cleveland with opportunities for travel to attend engineering meetings and expositions.

If you are interested, send full details of your engineering background to the Editor, MACHINE DESIGN, Penton Building, Cleveland 13, Ohio

MOVING A MOUNTAIN INTO A LAKE

25 million tons of gravel ride on SKF-equipped conveyors

In one of the largest earth-moving projects ever undertaken, a 13 mile dry-land roadbed is being built across the Great Salt Lake for the Southern Pacific Railroad. The construction company is using over 2 miles of Hewitt-Robins belt conveyors to transport 25 million tons of gravel into the lake for roadbed foundation.

Operating at speeds up to 850 feet per minute, this conveyor system delivers 75,000 tons of gravel per day.

Naturally, all components of this tremendous conveying system had to be chosen for rugged dependability, thus Hewitt-Robins selected 226 SKF (Type SAF) Pillow Blocks and Bearings for this application.

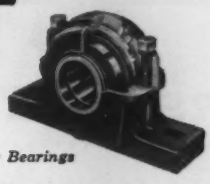
There were two major reasons for this choice: a) The SAF Pillow Block is available with the "Type C" Spherical Roller Bearing which provides up to 50% more capacity than other type sphericals; b) the SAF's Triple Seal which effectively seals dirt out of the housing and also retains lubricant.

No matter what your application, remember *only* SKF offers all types of anti-friction bearings, and a complete line of pillow blocks and flanged mountings. Remember, too, that an SKF field engineer is always ready to assist you in putting the right bearing in the right place. For further information consult your local SKF district sales office.

7781

SKF®

EVERY TYPE—EVERY USE



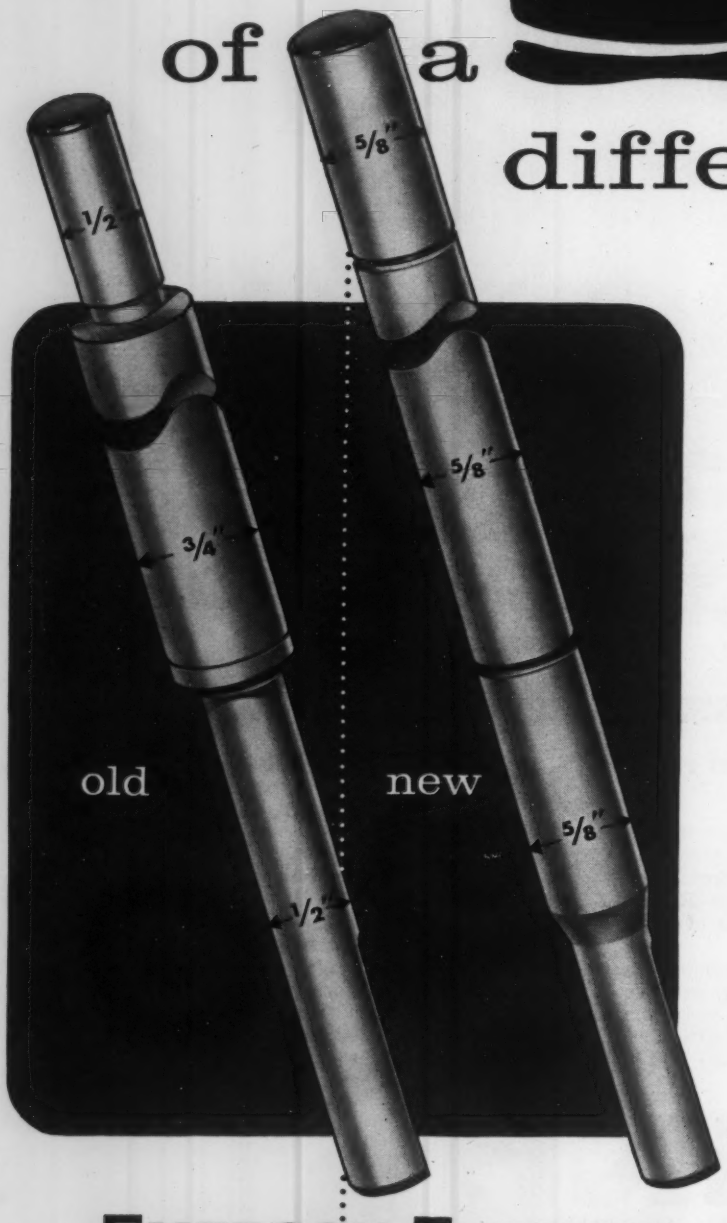
Spherical, Cylindrical, Ball, and "Tyson" Tapered Roller Bearings

*Reg. U.S. Pat. Off.

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

Circle 454 on Page 19

1/8-INCH made a whale of a difference



Designed for you...the motor buyer... an entirely new motor shaft, that assures longer life, more dependable motor power for your laundry equipment product.

This new 5/8" shaft reduces bearing wear...provides rapid heat dissipation...greater load-carrying capacity...lower average noise level...reduced end play, and practically stops end-play "growth".

Just another reason to always specify Emerson-Electric Custom-Engineered motors! WRITE TODAY for complete details...
Dept. M-84
The Emerson Electric Mfg. Co.,
St. Louis 21, Mo.

Shaft (left) is now being replaced by new-design 5/8" shaft (right) in all Emerson-Electric Motors for laundry equipment.

EMERSON-ELECTRIC of St. Louis

LIVE BETTER ELECTRICALLY

since 1890

Circle 455 on Page 19

For fractional to 40 hp drives . . .

BOSTON Gear SPROCKETS and CHAIN

FROM STOCK . . . at Factory Prices

Catalog No. 56 lists
ANY TYPE OR SIZE YOU NEED

.81" to 38.20" P.D.
SPROCKETS, iron and steel, for single ROLLER CHAIN

1.92" to 26.74" P.D.
SPROCKETS, iron and steel, for double ROLLER CHAIN

¼" to 2½" P. ROLLER CHAIN
single, double, and triple

1.94" to 12.74" P.D.
SPROCKETS, iron and steel, for BLOCK CHAIN

⅛" to ½" w. BLOCK CHAIN

.37" to 6.07" P.D.
SPROCKETS, bronze and steel, for LADDER CHAIN

.185" to .353" P. LADDER CHAIN
brass and steel

Save machining time

SHOLD-A-GRIP
interchangeable tapered
SPROCKETS and BUSHINGS
2.09" to 23.88" P.D. SPROCKETS adaptable with tapered BUSHINGS to shaft sizes ½" to 3" by 16ths

BORED-TO-SIZE
ready-to-install
SPROCKET PINIONS
Complete with keyway and setscrew. ⅜" through 1" P., in 76 tooth sizes, with 321 stock bores

You get BOSTON GEAR top-rated quality and lasting economy. You save time and expense when you buy from local stock — *at factory prices.* Be cost-wise — standardize. Boston Gear Works, 64 Hayward St., Quincy 71, Mass.

CALL YOUR **BOSTON Gear** DISTRIBUTOR

For nearest Distributor LOOK UNDER "GEARS" in the 'Yellow Pages'

7124 "OFF-THE-SHELF" TRANSMISSION PRODUCTS **FROM STOCK** — AT FACTORY PRICES — ASK FOR CATALOG

Stock Gears • Sprockets and Chain • Speed Reducers • Bearings • Pillow Blocks • Couplings

ROLLWAY THRUST BEARINGS...

$\int_{2''}^{36''}$ *Design + precision + quality that do the job in the one best way...*

Size in Rollway Thrust Bearings—big or little—is a mere matter of operating "geometry" and of the machinery to produce it. But design, precision and quality are dimensionless quantities that vary widely according to loads, speeds, temperatures . . . yet in the end sum up to a single constant: *"To do the job required in the one best way."*

Of course, we're proud of this 2¼ ton bearing with its thrust load capacity of 4,630,000 lb., its diameter of almost 3'-0" and its 3 roll assemblies with 6 precision thrust plates matched to equalize load and deflections for each stage. But we're equally proud of the little 2 incher in Design Engineer Grigson's hand. Despite the great difference in size, each has been carefully worked out *"to do the job required in the one best way."*

Whether you want a bearing for an oil rig, an extruder, a pulp mill jordan, a crane hook, a heavy duty lathe and countless other uses, Rollway has one that will do the job "in the one best way."

5 Standard Types:

- Single aligning
- Double aligning
- Tandem
- Single acting
- Double acting

- Special-purpose types to your order

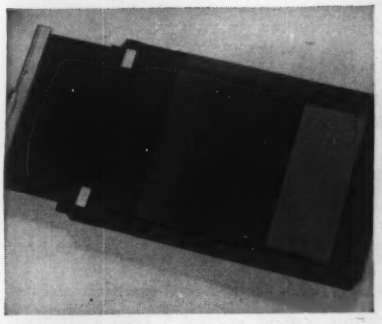
Our engineers will gladly consult with you regarding the standard or special-purpose types you need.

ROLLWAY®
BEARINGS
COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

ENGINEERING OFFICES: Syracuse • Boston • Chicago • Detroit • Toronto • Pittsburgh • Cleveland • Milwaukee • Seattle • Houston • Philadelphia • Los Angeles • San Francisco

take it in color

and you put Synthane laminated plastics to work



Slide for cut film holder—made from Synthane sheet because Synthane is opaque to infra-red rays.

At first glance the connection between color photography and Synthane laminated plastics may seem obscure. Actually, Synthane has long been at home in the manufacture and processing of film and in the developing of the finished picture.

Many types of rolls, loop sticks, and structural parts made of Synthane are used by the film manufacturer. Racks, film sprockets, reels and rollers employ Synthane in developing processes. In the infancy of color pictures (and ever since), racks and reels made of Synthane proved to be exactly what were needed to resist developing solutions, prevent film fogging through contamination. Film holder slides and various parts for cameras are other uses of Synthane in photography.

The photographic industry needs Synthane for its unique combination of properties. Resistance to moisture and chemicals, non-fogging qualities, its hard, smooth surface are all important characteristics. Synthane is tough, light in weight (half the weight of aluminum) and easily machined. These and many other chemical, electrical and mechanical properties make Synthane valuable throughout the length and breadth of industry.

Over 30 grades in sheet, rod or tube form or completely fabricated by us are looking for work with you. Write for information.

CHEMICAL RESISTANCE

LIGHT WEIGHT

EASILY MACHINED

MECHANICAL STRENGTH

SYNTHANE . . . industry's unseen essential

SYNTHANE CORPORATION, 5 RIVER ROAD, OAKS, PA.

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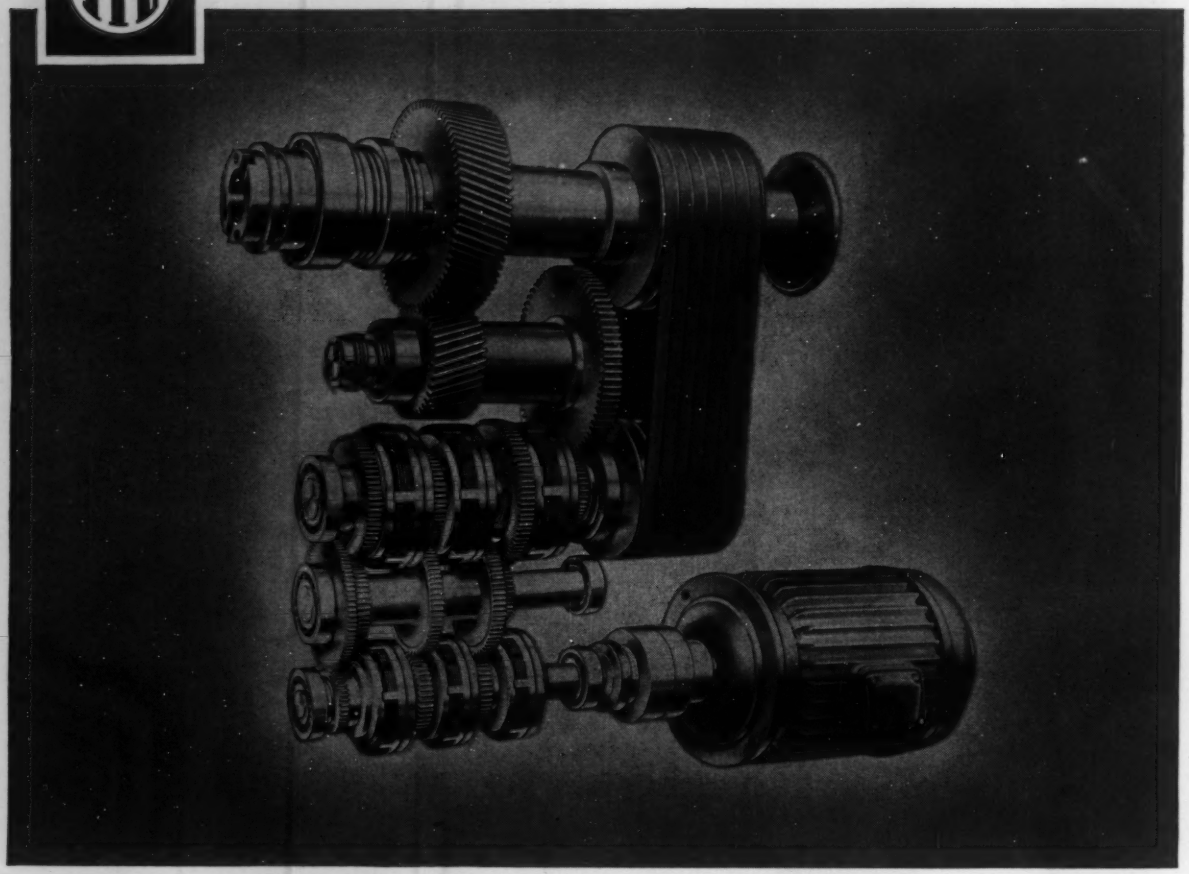
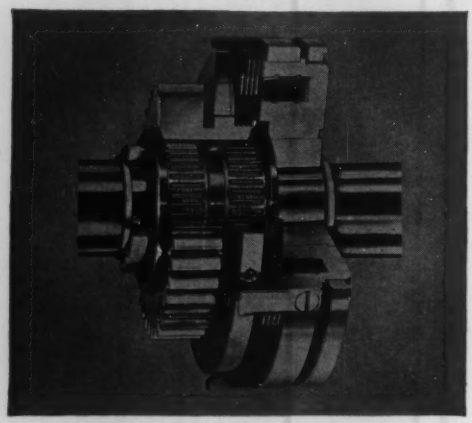
ELECTRO CLUTCHES



Milling machine drive using six I-T-E Electro Clutches and providing a total of nine speeds and braking. High-low range is attained by use of one slide gear.

CHANGE SPEEDS OR FEEDS ON THE FLY

by push button, limit switch, relay



Type H design showing unit construction.

FEATURES:

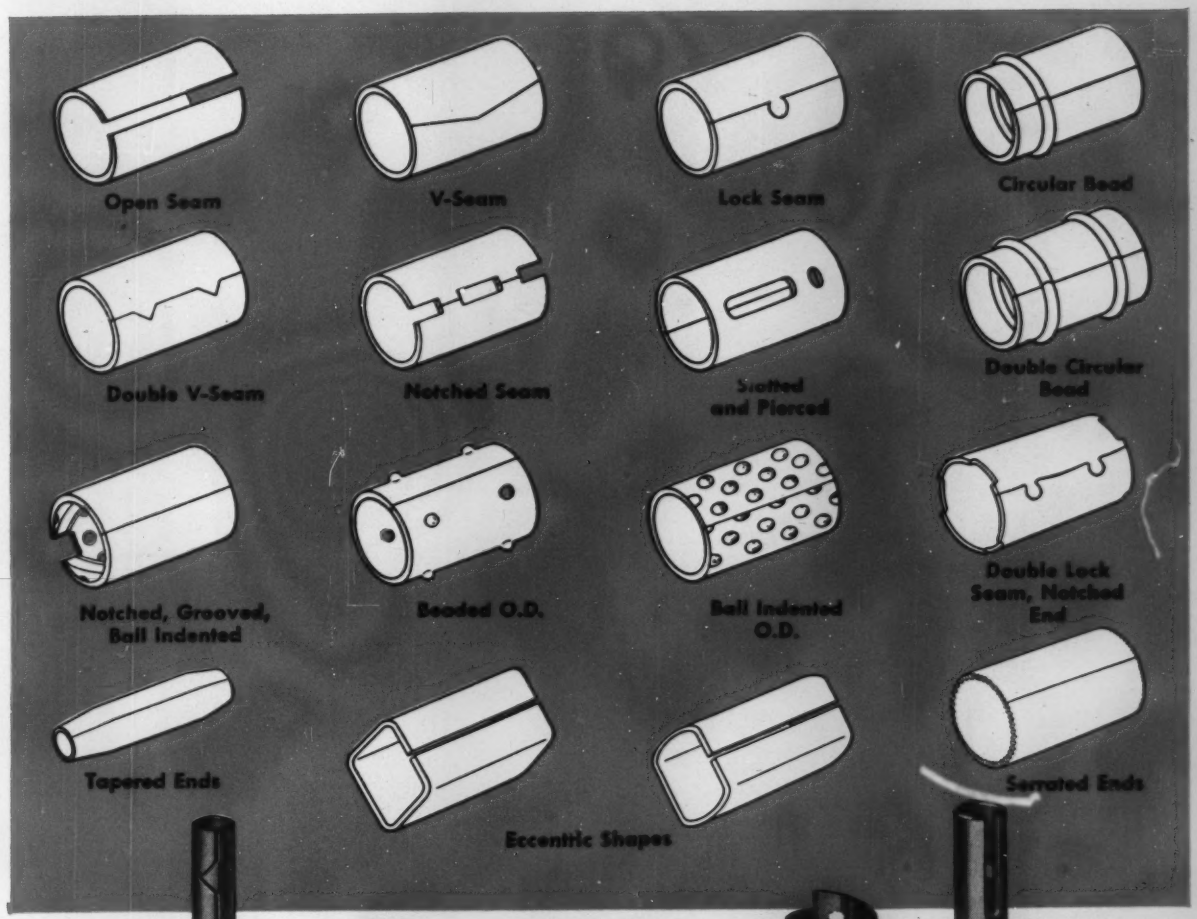
- **No adjustments required for wear**
- **Simply and easily installed**
- **Positive operation**
- **No complicated wiring**
- **Fast response**
- **Cushioned operation—no shock loading of gears or shafts**

Tapered torque ratings from 3.2 to 13,000 lb.-ft. make possible the selection of the correct I-T-E Electro Clutch for the application. For complete data, write for Bulletin 5306.

I-T-E Circuit Breaker Company, Transformer & Rectifier Division, 19th & Hamilton Sts., Phila. 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY
Transformer & Rectifier Division

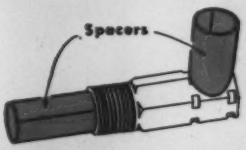
Circle 459 on Page 19



Rolled Split Steel Spacer Tubes in Great Variety and at Low Cost

Used in hundreds of automotive, appliance, farm implement and wheeled goods assemblies, they save time, labor and costly materials. An economical substitute for iron pipe, tubing or machined parts, they are delivered ready for assembly, to exact dimensions. A special catalog with design data is available, without obligation. Address:

FEDERAL Mogul SINCE 1899



Spacers can be furnished with brazed seams and we can braze spacers to other components, as shown here.

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11045 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

Circle 460 on Page 19

HOW WOULD YOU CAN a Neutron?

ZIRCONIUM . . . because of its low absorption rate for free neutrons . . . has been selected for use in atomic reactor plants now under construction. This rare wonder metal is derived from the black specks present in ordinary beach sand; in tubular form it serves as a container or can for the uranium pellets used in the fuel packages.

As a pioneer, Damascus has successfully welded zirconium tubing in several sizes and is now prepared to quote on production runs of Zirconium, Zircaloy 2 and Zircaloy 3 for reactor applications.

Write for complete information

DAMASCUS TUBE COMPANY

STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA

FORMED STEEL TUBE INSTITUTE

good for MILLIONS

of operations in basic automation controls

WESTINGHOUSE CONTROL RELAYS

TYPE NH RELAY
UP TO SIX POLES
10 amp, 600 volts

Where long life and dependable relay control of electrical circuits are required, Westinghouse Type NH relays are ideal. They operate efficiently on low current from pushbutton stations, temperature or pressure devices, limit switches, photoelectric or other controls.

Case-hardened operating parts provide tough, wear-resisting surfaces for longer operating life. Knife-edged minimum friction bearings, prevent binding or delayed action. Circuit continuity is further guaranteed by neoprene shock-absorbing mounting. Fine silver contacts close with firm pressure, and low resistance.

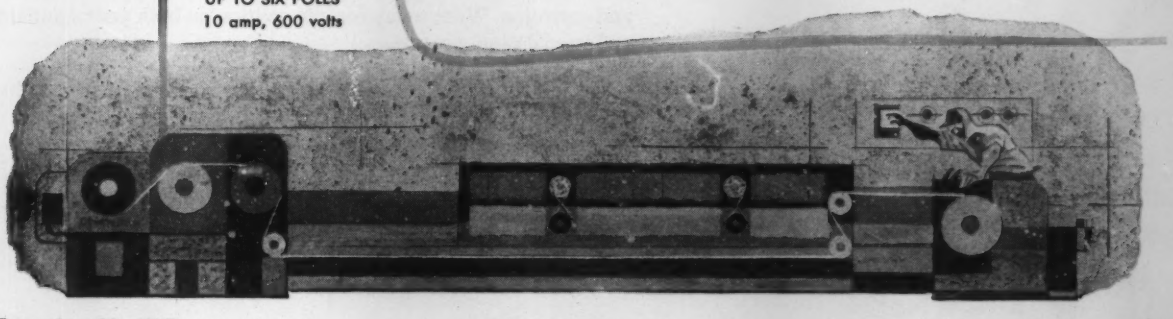
All parts, including coils and cores, can be easily removed from front. Readily changeable for adapting to voltages through 600 volts.

Supplied in any combination of normally open or closed contacts . . . up to six poles. Combinations easily changeable in the field without additional parts.

YOU CAN BE SURE...IF IT'S **Westinghouse**

Type NH is one of a full line of Westinghouse relays.

Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-30257



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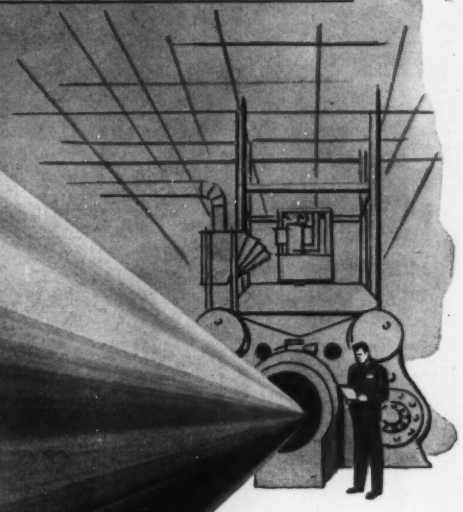
FOR YEARS OF PIPE ECONOMY...



THIS EXTRUDED HEAVY WALL

PROTECTS

against severest heat, pressure and corrosion

Here is High Integrity pipe for the toughest applications in the power, petroleum, chemical and other industries. Extruded from any ferrous alloy in lengths up to 50 feet or more, and with virtually any wall thickness, this pipe from the Curtiss-Wright Metals Processing Division provides increased on-the-job life, long-term economy, elimination of down time – not just for months, but for years to come. Extruded to specification under tremendous one-push pressures from the Division's giant 12,000-ton horizontal steel extrusion press, Curtiss-Wright Heavy Wall Pipe is of uniform high strength and has high resistance to pressure, heat and corrosion. Write today for information on both your standard and special requirements.

71 GRIDER STREET

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CORPORATION • BUFFALO, N. Y.

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Circle 463 on Page 19

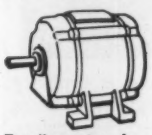
NEW Elliott C-W type N Motor PERMANENTLY SEALED Against Dust, Moisture, Corrosive Fumes

The rugged "Sealedpower" cast frame Elliott motor shown above is the modern version of the design pioneered in this country by Crocker-Wheeler. An external fan, made of sparkless material, and surrounded by a cowl, blows air along the frame for highest cooling efficiency. An internal fan provides continuous air circulation within the enclosure. All openings in the frame are tightly sealed, providing complete protection to windings and working parts.

Once applied only in locations where extremely destructive atmospheric conditions prevail, totally-enclosed motors are today rapidly gaining acceptance for all types of applications. Users find that the total over-all cost—first cost plus maintenance—is less than that of open or semi-enclosed motors.

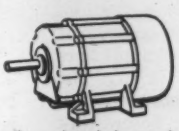
Ask your Elliott representative for details, or write for the new type N motor bulletin. Address Elliott Company, Crocker-Wheeler Division, Jeannette, Pennsylvania.

OTHER C-W TYPE N MOTOR ENCLOSURES



Totally-enclosed non-ventilated

Dripproof Protected



Totally-enclosed, fan-cooled Frames 256 U and smaller

ELLIOTT Company
CROCKER-WHEELER DIVISION

We will be glad to send a copy of this new booklet describing the complete line of Elliott C-W type N motors. Please write on company letterhead.

W6-6

Circle 464 on Page 19

Up to 40% higher tightening torques keep a

—and only the combination of an UNBRAKO screw

RECOMMENDED SOCKET SET SCREW TIGHTENING TORQUES (Inch-Pounds)

SCREW SIZE	UNBRAKO	SET SCREW B	SET SCREW C	MINIMUM DIFFERENTIAL %
#4	5	3.9	3.5	28
#5	9	7.8	7.4	15
#6	9	7.8	7.4	15
#8	20	14.7	14.5	36
#10	33	26.5	25	25
1/4	87	62	60	40
5/16	165	122	125	32
3/8	290	198	225	29
7/16	430	309	350	23
1/2	620	460	500	24
5/8	1225	1106	1060	11
3/4	2125	1540	1800	18
7/8	5000	3660	4600	9
1	7000	5025	6500	8

The High-Torque UNBRAKO socket set screw is made to withstand the highest tightening torques ever used to seat a set screw—up to 40% higher than an ordinary set screw. But to take full advantage of this UNBRAKO feature you must have a key that can apply the force required to seat it without damaging the screw or snapping the key. The High-Titan UNBRAKO hex key is designed specifically to set a High-Torque UNBRAKO so that you can be assured of full *high-torque* performance every time.

Here's why a High-Torque UNBRAKO can be seated tighter—and stay put

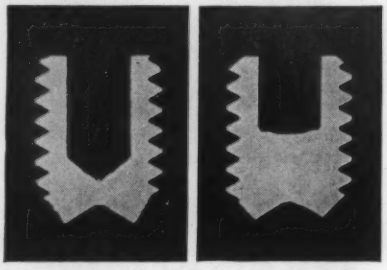
UNBRAKO SET SCREW

It has fully formed threads that make the whole screw stronger. The metal is compressed into the closely knit grain structure that you see in this illustration. The grain flow follows the contour of the threads. There are no straight lines along which shear can occur. The UNBRAKO retains its flow lines even when ground down to .010 in. below root diameter. Screws with cut or ground threads lose thread form at root diameter.

UNBRAKO SET SCREW

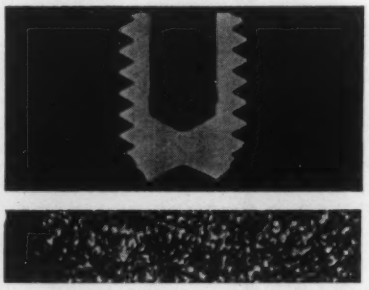
The High-Torque UNBRAKO has a radius in the socket corners. This eliminates the sharp corners where cracks start. It also distributes the stresses developed when tightening torques are applied. Ordinary socket screws have sharp corners which often crack when tightened even at lower torques than those recommended for UNBRAKO.

UNBRAKO SET SCREW **ORDINARY SET SCREW**



The High-Torque UNBRAKO has a deeper socket, which gives you more purchase with the wrench. Since more wrench can be put into the UNBRAKO socket, you can set the screw much tighter. And you won't ream the socket or round the corners of the wrench.

UNBRAKO SET SCREW

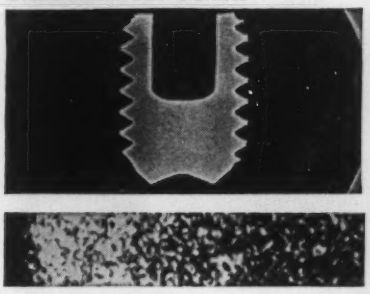


The High-Torque UNBRAKO is properly heat treated, kept clean. Its grain structure is uniform. It is free of decarburization. There's no danger of stripping the threads or shearing the point when tightening

High-Torque UNBRAKO socket set screw tight

and key assures full *high-torque* performance

ORDINARY SET SCREW



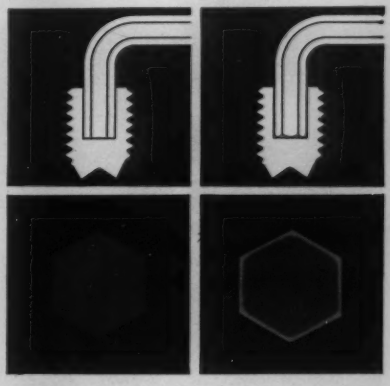
torques are applied. The ordinary screw is suffering from an overdose of decarburization; socket walls, threads and point are full of the telltale white spots that identify it.

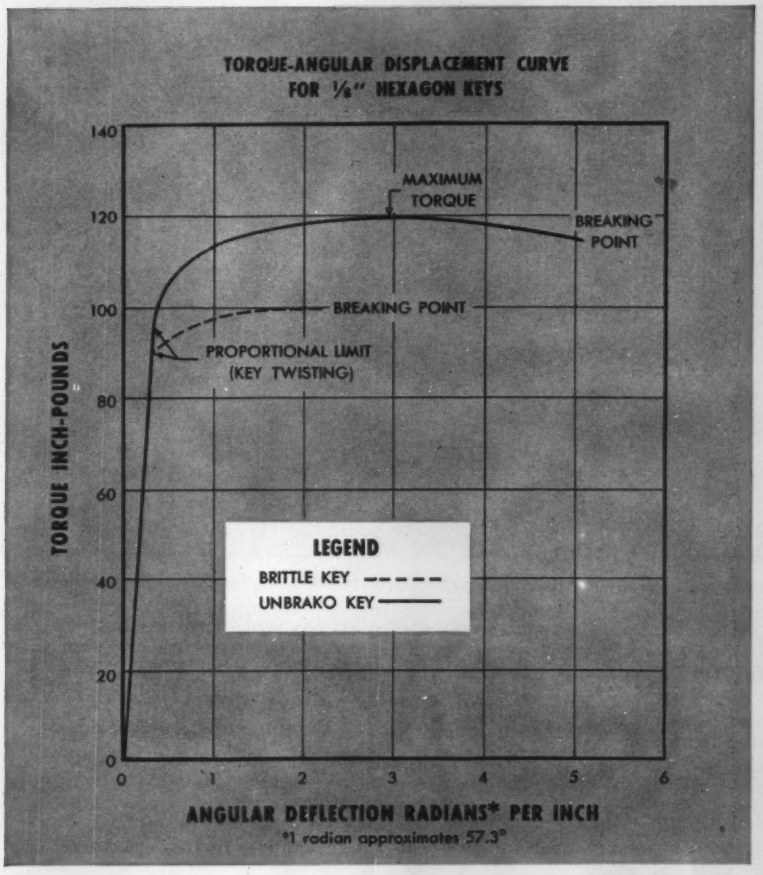
And here's why an UNBRAKO High-Titan hex key can be used to apply far more tightening torque to a High-Torque UNBRAKO socket set screw than is needed without damaging either the screw or the key.

The High-Titan UNBRAKO is not an ordinary hex key. It is a precision internal wrenching tool with high ductility, specially designed to assure full high-torque performance. It is made of special alloy steel bar stock, inspected magnetically and chemically to make sure that the material is flawless and of the specified properties. Its sides are flat and parallel. The corners, which exert torque on the inner walls of the socket, are sharp and tough. The bend is strong.

The High-Titan UNBRAKO is accurately sized across the flats and across the corners to insure snug fit and full wall contact. It won't ream or wear an UNBRAKO socket. The square cut end engages the full depth of the socket for greater tightening power. It gives you up to 25% more wrench engagement than a key with a chamfered end.

UNBRAKO KEY **CHAMFERED END KEY**





The High-Titan UNBRAKO hex key is heat treated in modern atmosphere-controlled furnaces. The surface is casehardened without decarburization. The extra hard surface gives the key longer life. And it retains its dimensional accuracy, is tougher and more ductile than ordinary keys. This torque-angular displacement curve for 1/8 in. hexagon keys distinguishes a High-Titan UNBRAKO from an ordinary key. The High-Titan UNBRAKO has a higher yield point and a higher breaking point—you can exert a much higher torque with it without snapping the key.

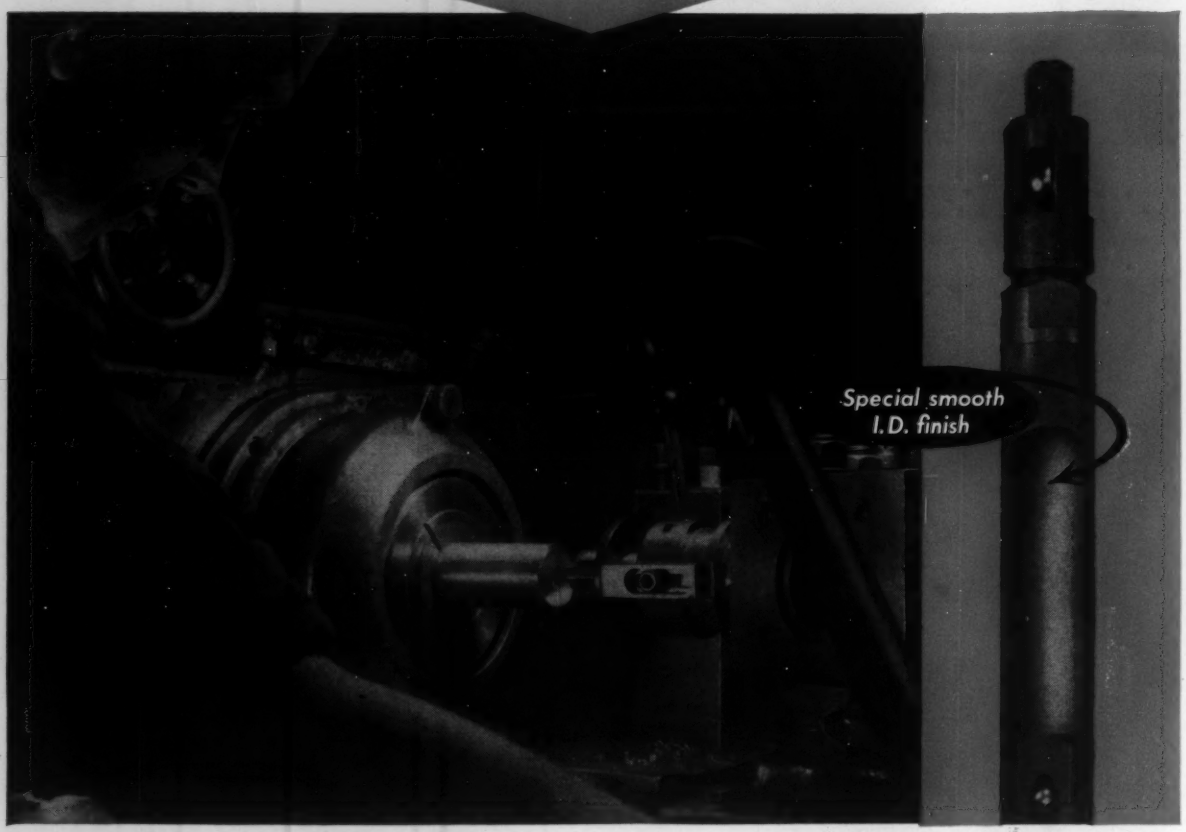
Be sure you get the full high-torque performance offered only by the combination of a High-Torque UNBRAKO socket set screw and a High-Titan UNBRAKO hex key. Both products are stocked by authorized industrial distributors. Ask the one nearest you for complete information. Or write STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

We also manufacture precision titanium fasteners. Write for free booklet.

Unbrako Socket Screw Division **SPS** **Jenkintown, Pennsylvania**

Standard Pressed Steel Co. • The Cleveland Cap Screw Co. • Cooper Precision Products • Standco Canada, Ltd. • Unbrako Socket Screw Co., Ltd.

This pump manufacturer reports 25% savings with J&L COLD DRAWN ELECTRICWELD TUBING



Operator is threading 1¾" O.D. x 1½" I.D. J&L special smooth *cold drawn* Electricweld tubing for pump cylinder.

Low original cost and elimination of interior honing are two reasons why it pays you to specify J&L *cold drawn* Electricweld tubing with special smooth I.D. finish.

This manufacturer of oil well insert pumps reports a saving of 25% by converting from honed seamless tubing to *cold drawn* special smooth I.D. Electricweld tubing. Not a single tube failure has been reported from the field.

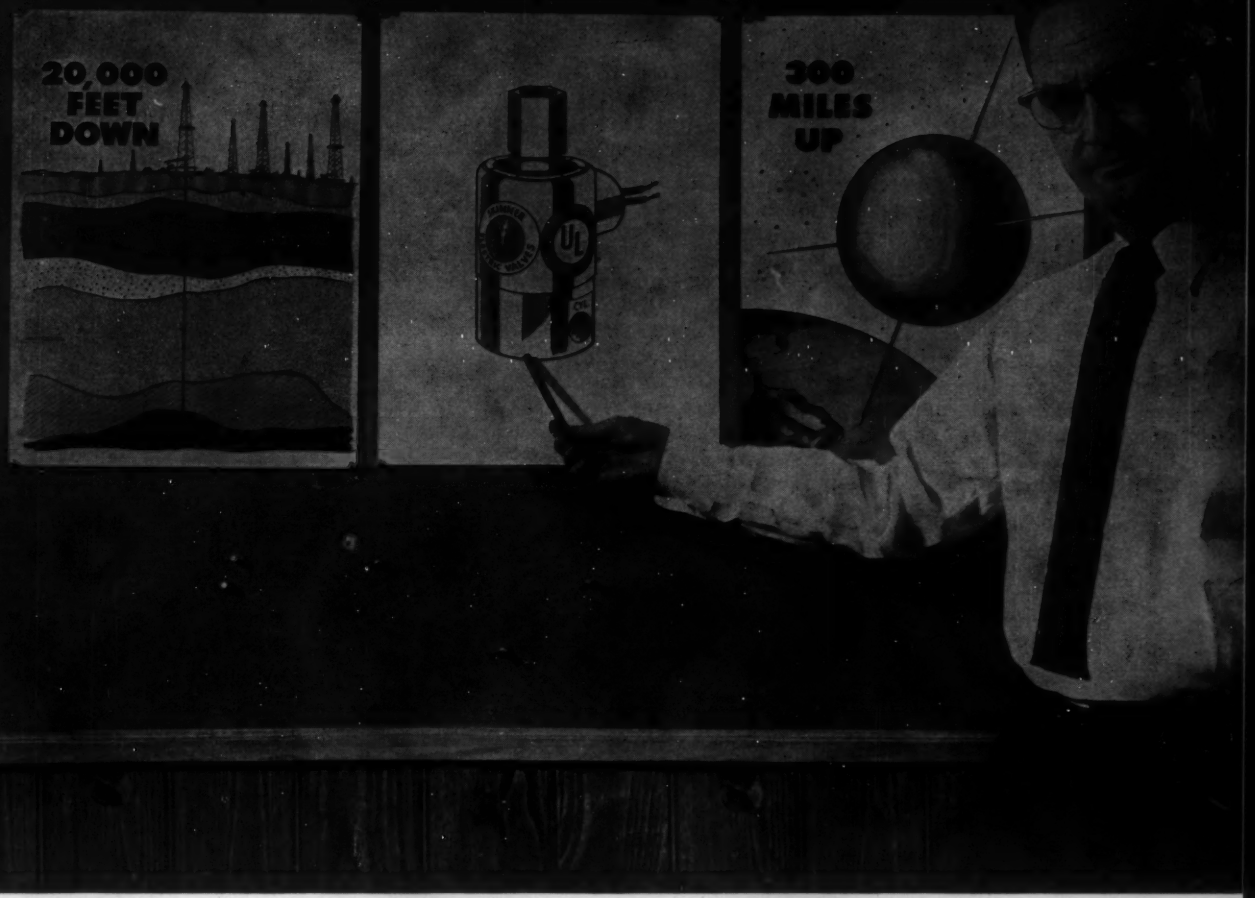
Because of its superior inside surface finish, exact tolerances and closely controlled physical characteristics, J&L *cold drawn* Electricweld tubing is recommended for these applications:

- *cylinder tubing* • *shock absorbers*
- *ordnance parts* • *hydraulic and pressure tubing*

J&L *cold drawn* Electricweld tubing is readily available in diameters from ¾" O.D. to 4¼" O.D., 8 gage to 20 gage, and can be furnished to closer than commercial tolerances. Write to Jones & Laughlin, 3 Gateway Center, Pittsburgh 30, Pa.

Jones & Laughlin
STEEL ... a great name in steel

Circle 466 on Page 19



The versatile design of Skinner Solenoid Valves makes their applications almost unlimited

Skinner Solenoid Valves have such great versatility that no one, not even their makers, knows the full extent of their applications. The range of their extremes demonstrates this vividly. One Skinner valve is being used in an instrument in Texas oil wells that tells the nature of earth strata 20,000 feet below the surface. Another one will be used to help launch the satellite that soon will be circling the globe.

If you have a problem that a solenoid valve might conceivably solve, we urge you to talk to a Skinner representative. Fill him in on the nature of your application. He'll be glad to work with you in selecting a valve that matches your requirements as to port sizes and locations, voltages, pressures, temperature conditions, flow adjustments and mountings.

For complete information on Skinner's line of 2-, 3- and 4-way valves, write us or contact a Skinner representative. Write Dept. 42 N.

Skinner Solenoid Valves are distributed nationally

Circle 467 on Page 19

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN
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Sigma Welding
gets truck trailers on the road fast

High-speed production of aluminum truck trailers calls for fast and efficient methods of welding. LINDE's Sigma Equipment and LINDE Argon keep trailer production lines rolling.

LINDE Apparatus for Sigma welding makes top-quality joints in all commercial metals. Production speeds up to 100 inches per minute are easily obtained, with clean, smooth welds. LINDE Argon, guaranteed 99.99% pure, is used to shield the arc. It's readily available in cylinders or in bulk, from convenient sources all over the nation.

Find out how LINDE Sigma Apparatus and LINDE Argon can help improve your product and increase your production. For a free copy of the booklet, "Modern Methods of Joining Metals," address Dept. Q-15. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

FOR THE BEST IN ELECTRIC WELDING—LOOK TO LINDE!

Sigma welding, with LINDE Apparatus and LINDE Argon, makes possible high-speed production welding of aluminum and other commercial metals, manually or automatically.

Linde TRADE-MARK

UNION CARBIDE

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

MACHINE DESIGN
November 28, 1957

The Price of Recognition

IS professional recognition of engineers a lost cause? During the recent era of apparent shortage, engineers were handed a once-in-a-lifetime opportunity. Did we use it wisely or did we fumble the ball?

Not so long ago prominent engineers and others were ready to push the panic button and were urging a crash program to develop more engineers. The resulting publicity set up the engineer as a key man whose services were vital to national security and progress.

What did we do? Collectively, we sought to improve our lot by legislation and bargaining. Individually, we shopped around and sold our services to the highest bidder.

Now that demand has eased and employers are becoming even more choosy in their hiring of engineers, the public ear is considerably less attentive. The memory of how we did act when our services were urgently needed will not readily be erased.

Because engineers are wholesalers of professional services rather than retailers, like doctors and lawyers, it is more difficult for us to impress the public. We are judged by the products of our efforts rather than by personal-professional contact, and the impression isn't always favorable. Regardless of the fairness of the judgment, our engineers lost prestige when a "backward nation of peasants" beat us into space.

We should be willing to earn the status we seek, by maintaining and improving our engineering competence as individuals and as a profession. And we should make our competence available as a professional service rather than as a commodity to be bargained for.

Sometimes it seems as if engineers are more enamored of the trappings than of the substance of a profession. The price of professional recognition is professional conduct. Let's hope we have been sufficiently jolted by recent events to be willing to pay that price.

Colin Carmichael

EDITOR

How to use

TECHNICAL WRITERS

to increase efficiency of engineering functions

By JOHN V. E. HANSEN
Business Manager
National Research Corp.
Cambridge, Mass.

Competent technical writers are valuable members of the engineering staff if their abilities are efficiently utilized. This article tells why writers are needed, where to look for writing talent, and how to correlate the joint efforts of engineers and writers.

THERE are many areas in which engineers can be assisted; the area of data preparation is typical. In many organizations, management has realized that the preparation of technical reports and manuals is a job for specialists and that efficiency of their engineering operations can be increased by supplementing the engineering staff with experienced technical-writing personnel of high caliber.

This conviction is not a belated recognition of a continuing problem—it is, in large part, due to the increasing demand (both in quality and quantity) for technical writing. However, despite progress in recent years, there are still many cases where management has not yet realized the full benefit to be reaped from this distribution of effort.

Allocating the Responsibilty: Among management, there appears to be several schools of thought on distribution of the writing assignments. Assuming that practices in effect today may be taken as an indication of management's attitude, there are three general variations in philosophy.

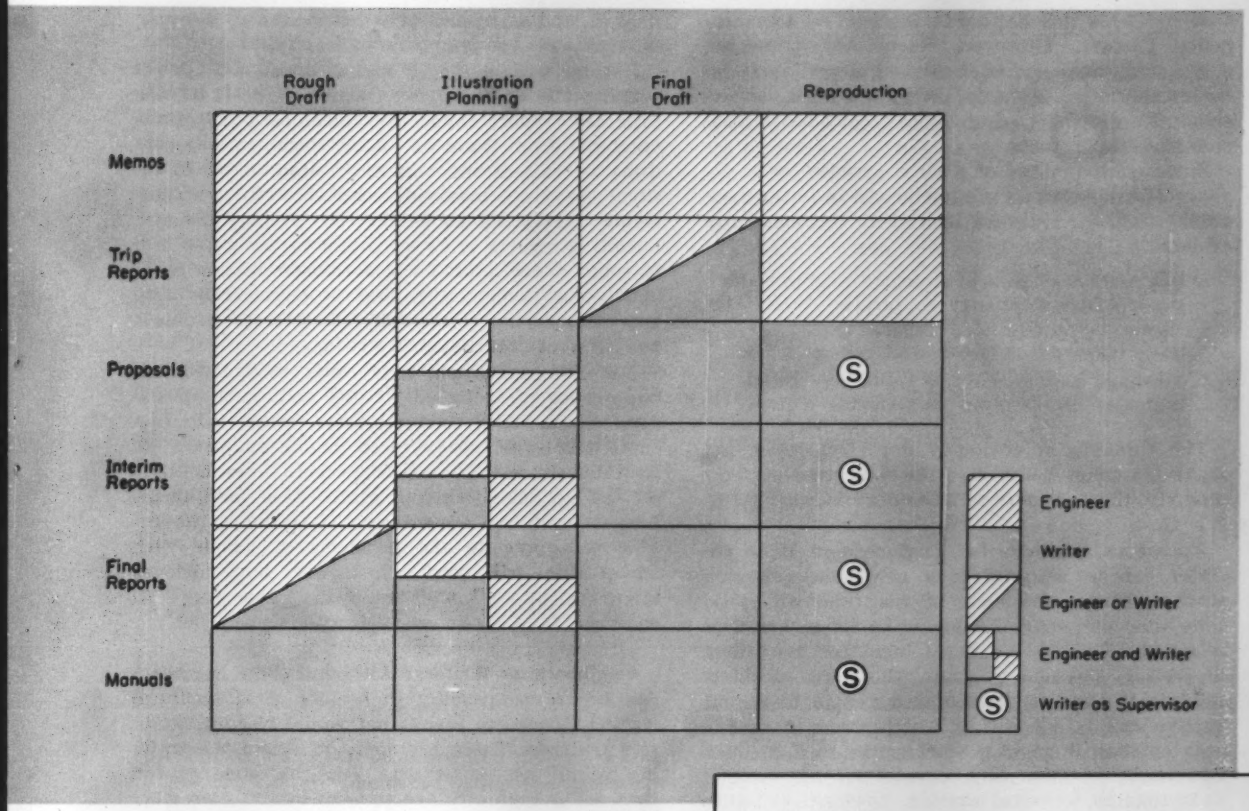
1. Engineers should be responsible for the preparation of all data and technical publications relating to a project.
2. Engineers should be responsible for all interim reports, but experienced technical writers should handle formal technical publications (proposals, final reports, handbooks, instruction manuals).
3. Experienced technical writers should be responsible for all publications, using engineers' notes and talking with the engineers for source material and technical guidance.

The rigid demands of technical writing, coupled with the general dislike most engineers feel for writing assignments, has made the first approach (engineers doing all the writing) unattractive to management in many organizations. There are also some instances where scientific or engineering personnel have taken the stand that the written word of a professional technical man is inviolate and should never be altered. In such cases, engineers automatically inherit the problem of preparing all the literature required. Fortunately, such instances are infrequently found.

The second approach (writing done by both engineers and writers) is used in many organizations, particularly where technical publications must be prepared to detailed specifications, such as are issued by many government agencies.

The third approach (all writing by writers) has not, as yet, received wide acceptance for several reasons. In some companies, the nature of the operations (size, complexity of subject matter, etc.) may not readily lend itself to such division of duties. In addition, many organizations have been unable to find technical writing specialists of sufficient competence to assume such responsibility with assurance of good work.

The Engineer-Writer Team: Regardless of the approach used, technical writers are not intended to relieve engineers, either wholly or in part, of responsibility for the technical accuracy of the material prepared. Basically, the technical writer is charged with the responsibility of enhancing the engineer's work by seeing that technical data is issued in its most attractive, accurate, and useful form, consistent with the specifications involved. Thus, the work of the technical writer is always



Distribution of writing responsibility between engineer and technical writer depends upon size of the organization, type of technical-writing talent available, and nature of the product. Certain general recommendations can be made.
This distribution assumes technical-writing talent of reasonable competence and experience. With more highly trained and experienced personnel, additional responsibility can be delegated.

subject to final review by the engineer.

Organizations that use the team approach realize that they can get more mileage out of their engineers by leaving the engineers free to perform basic engineering assignments. These companies provide their engineers with as much assistance as possible from nonengineering sources. In such cases, the company usually establishes an engineering-services department that offers, in addition to technical-writing assistance, such aids as prototype fabrication (machinists and technicians), and graphic arts (design draftsmen, reproduction facilities, etc.).

Usually, the services department is one of several departments in the engineering division and enjoys a status equal to that of other operating groups (research, development, etc.). This philosophy is reflected by groups such as the Laboratory for Electronics of Raytheon Mfg. Co.

Are Writers Necessary?: In an organization that does not provide technical writing assistance to its engineering personnel, frequently a project reaches the stage where work is progressing reasonably well, but the overall program is hampered (or even endangered) by lack of reports, handbooks, or other data. The solution in such emergencies is normally to divert some of the project engineers to the task of technical writing, or raid some other project for engineers to do the technical writing.

This overnight "conversion" of engineers into technical writers reflects a common misconception that engineers are capable of handling all technical writing assignments competently.

Today, when it is necessary to use our engineering talent as efficiently as possible, any attempt to convert experienced engineers (and physicists should be included) to technical writers is, in effect, taking our engineering wealth out of one pocket and putting it into another. This proce-

dure has been rationalized in the past as an emergency gesture. However, recent advertisements suggesting that experienced engineers turn to technical writing seem to have given such conversions the blessings of a logical, considered decision based upon facts.

Some shortcomings of such a decision seem obvious. If the situation is summarized in terms commonly used, the logic (or lack of it) becomes more evident.

1. Engineers must be kept at engineering, to make the available manpower go further.
2. Technical writers can relieve engineers of many tangential duties.
3. Technical writers must be technically trained; engineers can be used as technical writers.

The thinking is obviously imperfect, since the suggested solution destroys the first premise. Fortunately, there is more to be said about each point.

Engineers Available for Engineering: If an engineer can be assigned to a new nonengineering position where one hour of his time will yield more than one hour of engineering time, then time is saved. This is the basic logic for rewarding supervisory positions: A man who can co-ordinate and direct the activities of ten people to a productive end is, as a rule, worth more in such a position than if he were working as an individual. Ten engineers who each devote ten per cent of their time to technical writing, however, will turn out less actual engineering than nine full-time engineers working as a team with one competent technical writer.

Technical Writers can Relieve Engineers: Technical writing is a job for which the engineer is not trained by virtue of his engineering education. Technical writing is a field that requires specialized training—not in writing alone, but in writing, editing, photography, art, layout, reproduction processes, specifications, and the technical area in which the writer is to work.

This is not to suggest that an engineer be completely divorced from writing. He will, in the normal course of his work, be compelled to write such things as memos and field reports. Asking him to rough out the draft of his own progress report is within reason, and is a logical way of extracting data from the engineer. However, we should not go far beyond this point. The engineer should not be responsible for editing or processing his own reports, nor should he be expected to write drafts of formal technical reports, such as the handbooks and manuals often required on government contracts. An accompanying table gives a typical breakdown of responsibility for various writing jobs.

Competent technical writers can prepare formal technical publications on complex equipment with a minimum of assistance from the engineers. The progress report prepared by the engineers serves as the primary source of data. With additional data available from engineering drawings, test reports, and assistance of other personnel, the publication can be prepared efficiently.

Despite the seemingly logical division of duties —using the engineer for the rough draft of the progress report and the technical-publications specialist from there on—many organizations continue to extend the engineer's assignment to include the more involved technical writing assignments. Assigning an engineer to prepare his own technical reports is as inefficient as assigning him to spend a few hours each day on production problems. This irresponsible use of engineering time may also be the reason why the average engineer has little love for technical writing.

Some organizations have long recognized the importance of technical writing and make special concessions. For example, one large manufacturer starts all newly hired junior engineers off by having them serve a brief period (three months) on the technical writing staff. This assignment has at least two advantages: 1. It helps the engineers appreciate the problems of people with whom they will work. 2. It also may uncover latent talent that will result in "converting" an engineer to a technical-publications specialist.

Engineers as Writers: Although some engineers can be trained readily to become good technical writers, there are many that would require extensive training. There are some on whom the training would be lost effort. For the same reason that some engineers are temperamentally or mentally unsuited for research work, so are there those unsuited for technical writing.

A loss is involved while converting an engineer to a technical writer. An appreciable period of nonproductivity is involved while training a man for a new job. This suggests that the best engineer candidate for technical writing is the new graduate. As mentioned, some organizations accord technical writing staffs sufficient monetary and organizational recognition to make technical writing attractive to new engineers.

Engineering Training Not Vital: Assuming for the moment that we can successfully attract those engineers who would make good technical writers —the next question is, how necessary is it? Do all technical writing assignments require an engineering background? The answer is "no," and there are many statistics to support this. A survey of the Boston Chapter of the Society of Technical Writers showed that although 54 per cent of the members polled held bachelor's degrees, less than 20 per cent of the members polled held engineering degrees. Yet, all of those polled have full-time positions in the technical writing field covering complex engineering assignments.

Intelligent planning and organization can reduce the need for qualified engineers in the technical writing field. A nonengineer technical writer working under the supervision of a competent engineer, experienced in technical writing, can fulfill all technical writing assignments likely to be encountered.

Availability of Writers: The need for help in the nonengineer technical-writer category is a very real one. Fortunately, there are signs of a growing supply. In the Boston area, for example, in connection with the Society of Technical Writers, Tufts University has recently completed its third Technical Writers Workshop. A fourth is in progress. Training in technical writing has also been added to the curriculum in other schools. Rensselaer Polytechnic Institute has been notably active. One unexpected source of help may be coming from the distaff side. Boston's Simmons College has recently announced a four-year curriculum combining the sciences and publications. A future supply of competent technical writers can be assured by a three-point program:

First, by and large, it is necessary to keep engineers at engineering to make the manpower go further. But a judicious assignment of engineering personnel (preferably new employees) to technical writing is warranted to achieve this end.

Second, technical writers not only can relieve engineers of tangential duties, but should be used in preference to engineers who are untrained in technical writing.

Third, technical writers must be technically trained. The preferred method is to train a few engineers for the key positions in technical writing, and supplement them with nonengineer technical writers.

ADDITIONAL READING

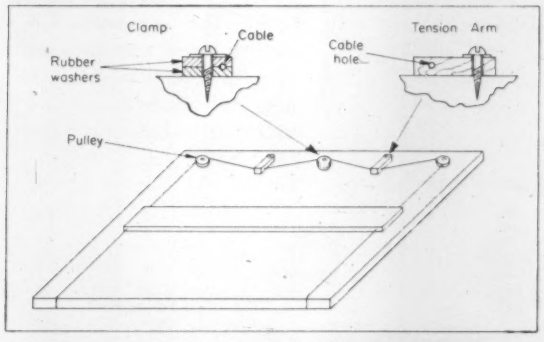
Earlier articles on technical writing, and correlating the efforts of writers and engineers, have appeared in the following issues of MACHINE DESIGN:

"Improving Technical Writing" ..... April 5, 1956
"Engineering Manpower Shortage" ..... May 17, 1956
"Engineering Writing" ..... March 7, 1957
"The Engineering Shortage" ..... July 25, 1957
"Standardizing Engineering Reports" ..... October 3, 1957

Tips and Techniques

Straightedge Lock

A simple device can be added to a drawing board to lock the straightedge cable yet allow adjustment of the cable tension. The lock is used in place of the standard take-up lock screw which has a tendency to cut the cable.



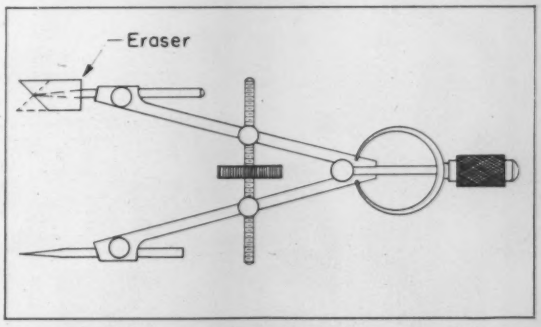
In the center of the board, near the upper edge, clamp the cable between two rubber washers held to the board with a screw. On either side of the screw, mount a tension arm so that it can pivot or be locked by a screw. The arm is drilled vertically for the screw and horizontally for the cable. The tension arms are pivoted to lock or release the cable.—JAMES T. DONNELLY *and* ROBERT L. BERARDO, *Johnson & Johnson, New Brunswick, N. J.*

Drawing Arrowheads

Neat, fast arrowheads can be drawn with a template. Using a template saves time and improves the appearance of the drawing. The arrowhead template is made by cutting triangles of desired size in a thin sheet of plastic. Plastic erasing shields, pocket calendars, and decimal-equivalent tables make good material for such a template.—R. B. AMBERSON, *product development engineer, The Oliver Corp., Chicago.*

Erasing Circles

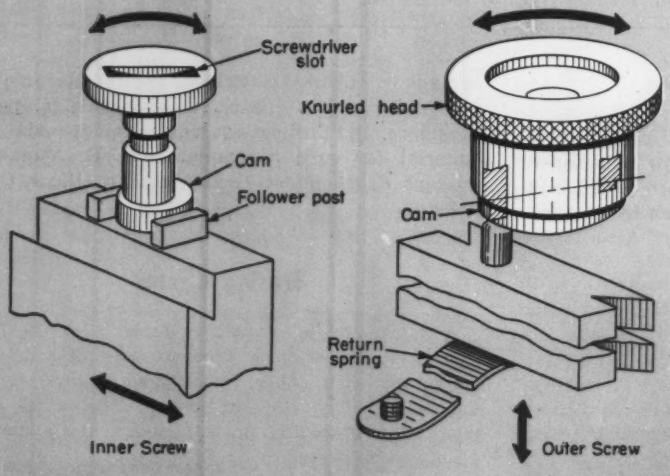
A draftsman is frequently faced with the problem of erasing a circle from an area of a drawing congested with other lines which should be left untouched. The slots in erasing shields are quite short and generally do not match the radius of circles to be erased.

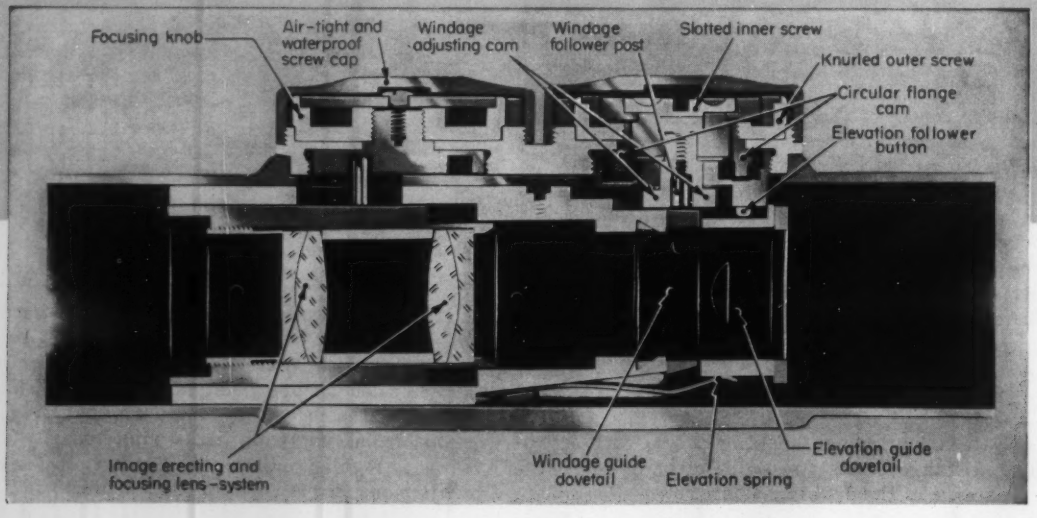


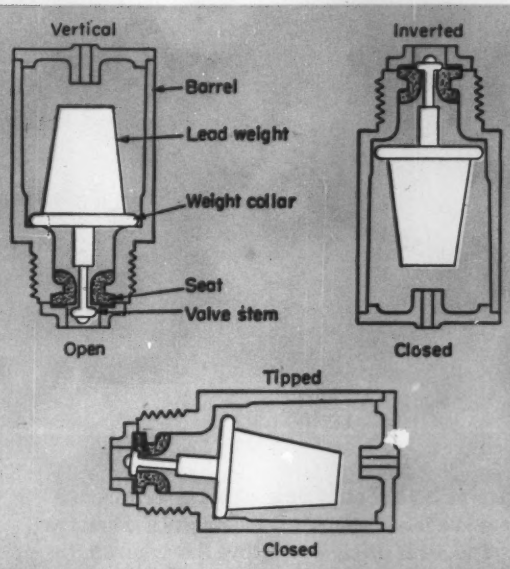
If the lines were not drawn with a too-hard pencil, the erasing can be done with a short piece of erasing-machine eraser, cut to a 45-degree angle, and impaled on one point of a divider. This will eliminate the errors or omissions that frequently result from redrawing areas unnecessarily erased with a regular eraser.—J. BARKEV KASSARJIAN, *draftsman, Lewis-Shepard Co., Watertown, Mass.*

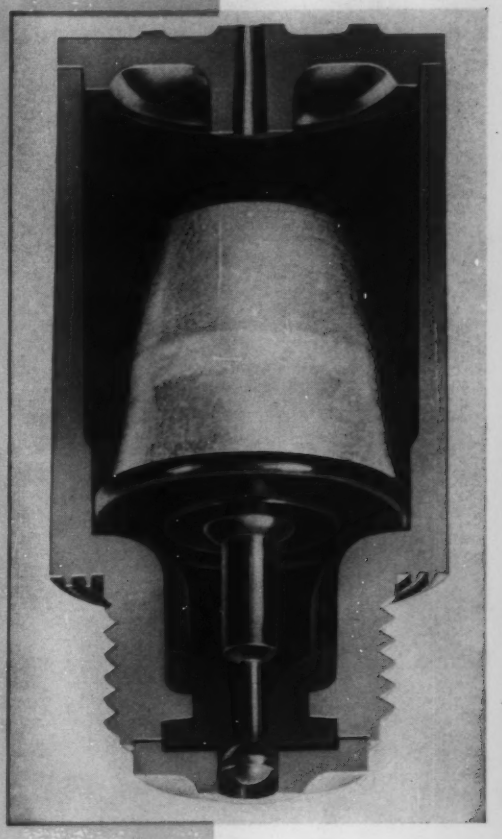
scanning the field for *ideas*

Compound adjusting screw offers compact unit for control of movement in two planes. The inner screw of the compound assembly controls movement perpendicular to the screw centerline by an eccentric cam on one end. This eccentric cam engages the sides of two follower posts on the driven member, causing linear movement as the screw is rotated. The outer screw of the assembly imparts movement parallel to the screw centerline. In this case, the driven member is spring loaded and has a follower button which bears against the circular cam surface of a flange at the end of the screw, causing axial movement of the driven member as the screw is rotated. The compound adjusting screw was designed by Weatherby's Inc. to provide windage and elevation adjustment in a rifle telescope sight.



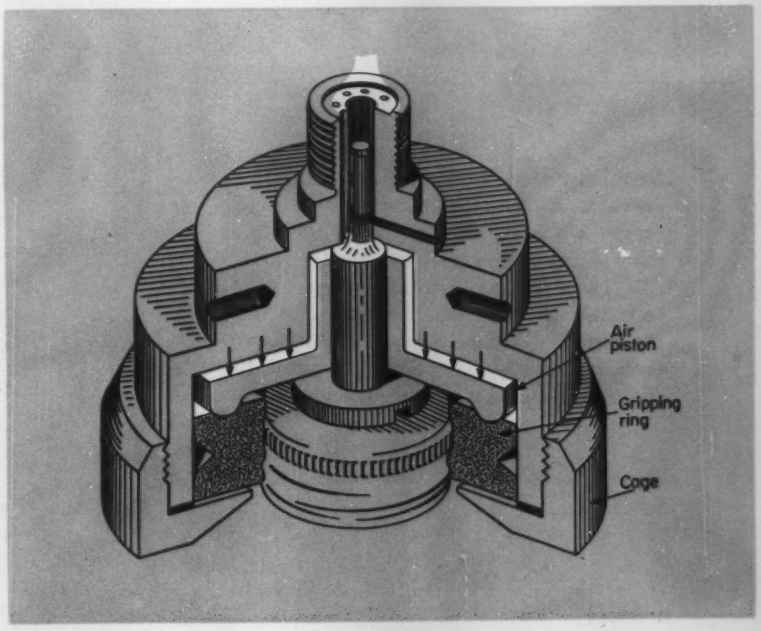


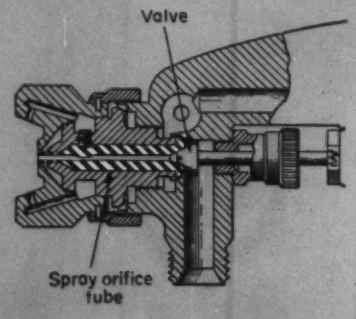




Nonspill valve closes automatically when tipped from the vertical position, to prevent accidental loss of fluid. A lead weight on the valve stem shifts within the barrel of the valve, pivoting on a collar at the base of the weight, pulling the valve stem onto its seat and closing the valve. The weight automatically returns to rest position and reopens the valve upon resumption of a vertical position. The valve, designed by Exide Industrial Div. of Electric Storage Battery Co., is used as a vent closure on aircraft batteries.

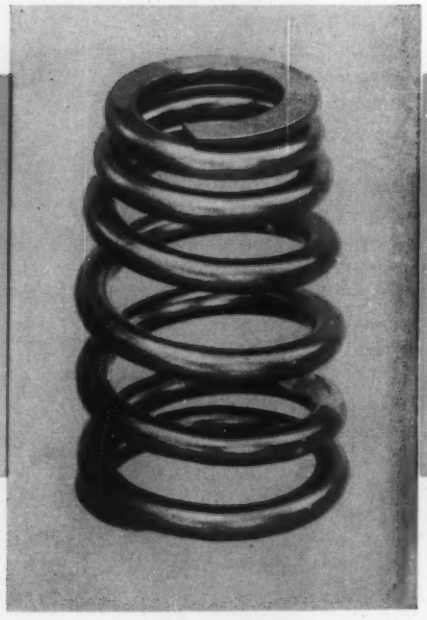
Flexible gripping ring in pneumatic "clutch" adapts itself to eccentricity, misalignment, or size variations of driven member. The doughnut-shaped neoprene ring, retained in a driving cage, is forced to deform and grip the driven member by an air piston. Upon application of air pressure, a raised ridge on the periphery of the air piston applies pressure to the flexible ring, squeezing the ring and reducing the inside diameter. The design was developed by Pneumatic Scale Corp. Ltd., to hold and drive bottle caps in an automatic capping machine.



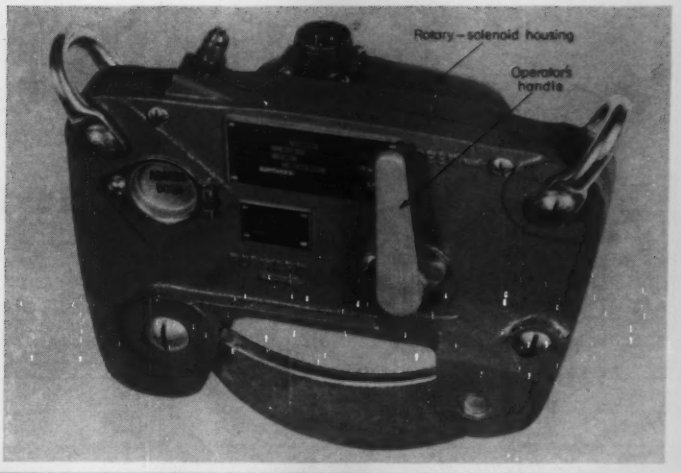


Pulsating rubber surface of spray orifice minimizes wear under action of high-velocity abrasive mixtures. The liner design, employed in the Smith-Patent spray gun reported by Lee Cuson, eliminates the wear problem encountered in steel orifices under highly abrasive service. Under the impact of abrasive particles in the material being expelled, the resilient surface of the liner "gives" locally, returning immediately to its normal configuration. With uniform flow conditions, the continuous pulsation of the surface of the liner aids in ejecting small solid particles which might otherwise cause clogging of the orifice.

Semiconical coil-spring design provides automatic damping of spring surge without auxiliary devices. In valve springs designed by the Oldsmobile Div., General Motors Corp., the coils lessen in diameter at one end of the spring. This diameter reduction gives each individual coil a different natural frequency, eliminating surge tendencies.

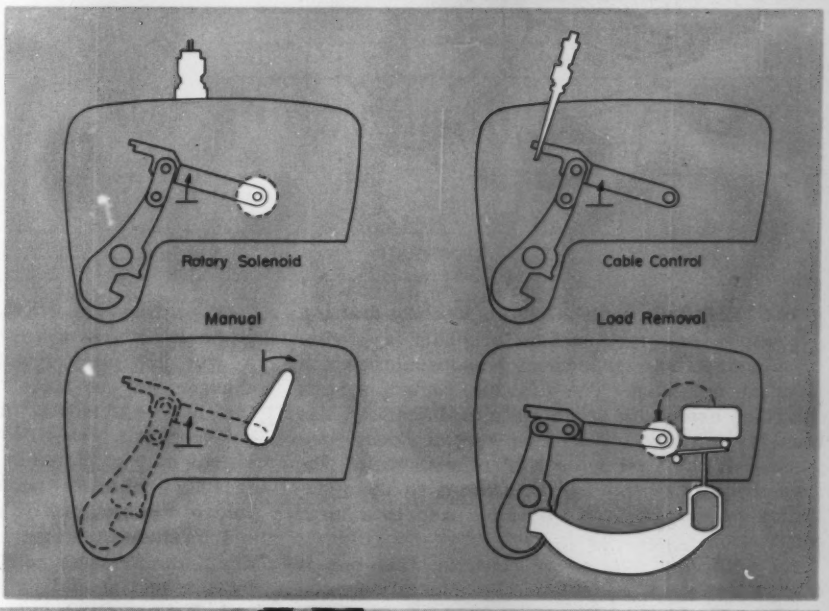


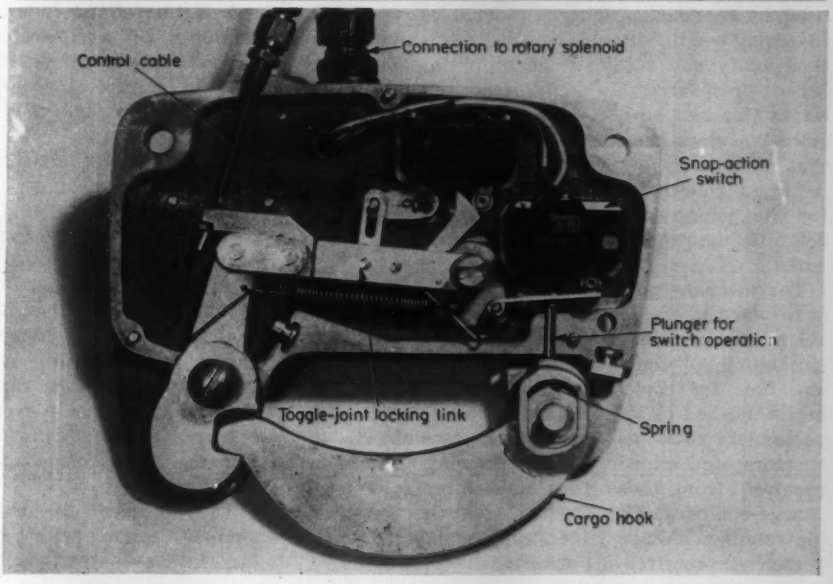
ideas

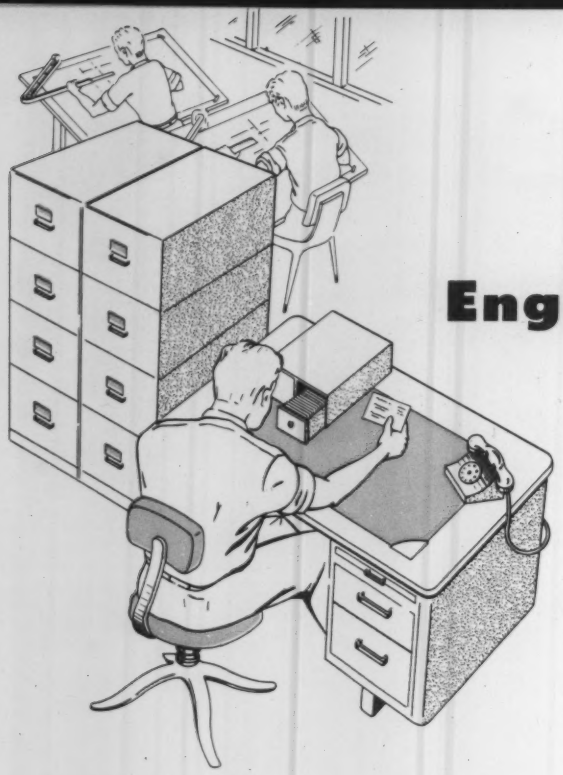


Optional actuation methods to meet different operating requirements are provided in a novel four-way releasing mechanism. In a cargo hook for helicopter service developed by Eastern Rotorcraft Corp., a toggle-joint lock on the release mechanism may be operated remotely, by electric or cable control; manually; or automatically upon removal of load.

The release is unlocked by rotation of one link of the toggle-joint lock. A rotary solenoid, actuated remotely, is provided to rotate the link. Mechanical rotation of the link can be accomplished through cable control and a manual operator's handle. Automatic release is provided by a snap-action switch: The mounting hole in the cargo hook is slotted; upon removal of cargo weight, the hook is forced upward by spring pressure to actuate a snap-action switch that energizes the rotary solenoid.







A method of

Engineering Drawing

By **WILLIAM B. WALLACE JR.**
Consultant
Wm. B. Wallace Engineering Co.
Inglewood, Calif.

SYSTEMATIC control of engineering-drawing copies and their vellum originals is a vital engineering-management responsibility which is often neglected. The drawing control system described here, with appropriate modifications, has been successfully installed in several small companies. With varying degrees of elaboration the fundamental precepts can be adapted to an organization of any size from a small shop to a large corporation.

As with any system of controls, this one is effective only to the extent of co-operation exercised by the participating personnel. Toward this end, one person should be assigned the full responsibility and authority for enforcing the established procedures. In small engineering departments this can be accomplished by giving the engineering clerk the keys to all files and requiring that all activity be controlled through this clerk. In larger concerns, of course, it will be necessary for the person in charge of engineering files to delegate appropriate responsibilities to subordinates.

The ultimate purpose of this system, of course, is to place in the hands of the production personnel proper drawing revisions and to remove from circulation all copies of obsolete drawings. Storage files for copies of current drawings should be established at locations accessible to production personnel, such as machinists, assemblers, inspectors, and expeditors. No drawings should be removed from these files unless replaced by a charge-out card, Fig. 1, which identifies the drawing number, change letter, copy number, and the person who received the drawing.

Of primary importance is the control of vellum originals. If free access is allowed to the vellums, it will inevitably result in confusion. Drawing changes may be made without proper regard for the next assemblies, production personnel may not be properly notified of changes, and new revisions may be placed in circulation without proper recall of obsolete prints. The vellum originals control system consists of three basic elements:

1. **Vellum Storage:** For convenience of handling, the drawing vellums should be stored first by size and second by numerical sequence.

2. **Vellum Card Index:** Each vellum should be cataloged on a separate card with the drawing number imprinted at the top. The cards are filed in numerical sequence. Fig. 2 and 3 illustrate the front and back sides of a typical vellum record card.

3. **Vellum Charge-Out Cards:** The charge-out cards for the vellums are the same size as the vellum index cards, and they are used to locate both vellums and vellum index cards that have been removed from the storage and file. A typical vellum charge-out card is shown in Fig. 4.

When time does not permit or the simplicity of a drawing change does not warrant making a change on the vellum, an engineering order (E.O.) is used, Fig. 5. This form is also used to authorize deviation from the print for a limited number of parts when a drawing change is not desired, Fig. 6. These forms are printed on reproducible vellum.

The procedure for drawing control is relatively simple. Starting with the original drawing vellum, the clerk prepares a vellum card, obtains the nec-

Control

PRINT CHARGE OUT CARD

DATE	PRINT NUMBER	CHARGE TO	CHG. LET. OR E.O.	COPY NO.
1-3-57	673-28	Wallace	N.C.	3
1-7-57	710-3	Molina	B	4
	298-101	Wright	F	6
	938-27	Molina	B	6

DATE	PRINT NUMBER	CHARGE TO	CHG. LET. OR E.O.	COPY NO.

Fig. 1—Typical charge-out card and record of an engineering drawing print. The last notation is always the current one.

PART NUMBER: 938-27 DRAWING SIZE: D
TITLE: 3004 - GAS PRESSURE REGULATOR
DRAFTSMAN: MOLINA ORIGINAL RELEASE: 4/3/57

REVISION DATE	CHANGE LETTER	E.O. NUMBER	REVISION BY	REMARKS
4-6-57		10232	C.M.	E.O.'s distrib
4-10-57		10333	C.M.	" "
5-2-57	A		C.M.	
5-4-57		10368	C.M.	E.O.'s distrib
5-10-57	B		C.M.	
5-15-57		10370	C.M.	
7-2-57		10394	C.M.	

Fig. 2 — Above — Front side of typical 3 by 5-in. index card for recording a vellum. Engineering order (E.O.) numbers are listed in sequence with letter changes. All E.O. numbers preceding a letter change have been incorporated on the drawing vellum. All E.O. numbers following the last letter change are to be incorporated on the next letter change.

Fig. 3—Below—Back side of vellum index card shown in Fig. 2. A record is kept of how many prints of each letter change have been distributed to the various departments.

PRINT DISTRIBUTION

REV.	ENGINEERING		LIAISON		SHOP		INSPECTION		PURCHASING		SALES	
	NO.	REC. BY	NO.	REC. BY	NO.	REC. BY	NO.	REC. BY	NO.	REC. BY	NO.	REC. BY
A	2	P.W.	1	M.M.	8	JJ	2	F.L.	1	P.B	0	
B	2	P.W.	1	M.M.	8	JD	2	F.L.	1	P.B.	0	

Fig. 4 — Charge-out card for vellums. This card is 3 by 5 in. and replaces the vellum index card when it is removed from the file.

VELLUM CHARGE-OUT CARD

DATE	VELLUM NUMBER	CHARGE TO
1-3-57	673-28	Wallace
1-7-57	710-3	Molina
3-10-57	298-101	Wright
7-2-57	938-27	Molina

Fig. 5—Below—Engineering order (E.O.) form used as a drawing-change notice when the change is to be permanent and is applicable to all subsequent parts. After the E.O. has been incorporated into the drawing vellum, a check mark will be made in the "chg. made" column. The change letter will be entered in the "let. chg." square.

PRPRO.	Molina	7/1
ENGR.	Wright	7/1
APPRVD.	Wallace	7/2
PART NUMBER		REV
938-27		B

INDUSTRIAL DESIGN LABORATORIES, INC.
CULVER CITY, CALIFORNIA

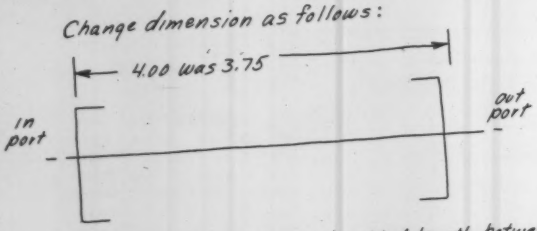
ENGINEERING WORK REQUEST AND ENGINEERING ORDER

E.O. #	10394	PAGE 1
PART NAME	REQUESTED BY	DATE
Body - Gas Pressure Req.	Sales	6/28/57

REQUEST AS FOLLOWS:

Change dimension as follows:

4.00 was 3.75



Reason: Customer needs added length between ports

						X				X			NEW DWNG
													LET. CHG
													NO LET
													TO BE INC
													NOT INCOR X
				ENGINEERING ERROR	PRODUCT. REQUIRMT.	PRODUCT. IMPROVMT.		REWORK	SCRAP	PARTS MADE O.K.	NO PARTS MADE	RECORD	
938-34	X			A	B	C	D	1	2	3	4	5	6
938-30		X		REASON				DISPOSITION					ENGINEERING ACTION
938-28	X			BLOCK FOR DEVIATION ONLY				LIMITED TO					PIECES
THIS PART	X			REASON:									O.K.
PART NUMBER AFFECTED	HOLD PROD.	OK	CHG. MADE DWG.										O.K.
													APP.

Fig. 6 — Above — Engineering order (E.O.) form used for making a print deviation when the change is not to be permanent. This example authorizes the inspection department to accept 12 pieces of a part not made exactly to print specs but which are still useable. The form can also be used to have mating parts modified to make other parts not made to print specs useable. This type of E.O. would not be entered on the vellum index card shown in Fig. 2 and 3.

PRPRO.	Molina	7/2
ENGR.	Wright	7/2
APPRVD.	Wallace	7/3
PART NUMBER		REV
938-27		B

INDUSTRIAL DESIGN LABORATORIES, INC.
CULVER CITY, CALIFORNIA

ENGINEERING WORK REQUEST AND ENGINEERING ORDER

E.O. #	10401	PAGE 1
PART NAME	REQUESTED BY	DATE
Body - Gas Pressure Req.	Inspection	7/1/57

REQUEST AS FOLLOWS:

Change dimension as follows:

6.25 was 6.00

Reason: To salvage body castings in stock. Customer agrees to change for 12 pieces.

													NEW DWNG
													LET. CHG
													NO LET
													TO BE INC
													NOT INCOR X
				ENGINEERING ERROR	PRODUCT. REQUIRMT.	PRODUCT. IMPROVMT.		REWORK	SCRAP	PARTS MADE O.K.	NO PARTS MADE	RECORD	
				A	B	C	D	1	2	3	4	5	6
				REASON				DISPOSITION					ENGINEERING ACTION
				BLOCK FOR DEVIATION ONLY				LIMITED TO 12					PIECES
				REASON: Mounting hole pads mis-located on casting.									O.K.
													O.K.
													APP.

essary prints, numbers each copy, records the print distribution on the vellum card, stores the vellum, and files the card.

If the engineering department issues an E.O. on a drawing, the clerk will enter the E.O. number on the vellum card. He will then have a copy of the E.O. made for each drawing print in circulation as noted on the vellum card. He will also personally make sure that the E.O. copies are permanently fastened to the drawing copies, and file the E.O. vellum in numerical sequence.

If the engineering department wants to make a drawing change, the clerk will pull the vellum card from the file and replace it with a charge-out card. He will then check the vellum card for unincorporated E.O.s and deliver the drawing and unincorporated E.O. vellums to the engineering office with the vellum card attached. The draftsman will add the E.O.s into the drawing vellum and will mark the drawing change letter on the E.O. vellum in the space provided. The draftsman will also check the E.O. for other drawings affected and requisition these drawings from the clerk. After the changes have been made, the drawing change column on the E.O. vellum will be marked and the proper notations will be made on the vellum card.

When the vellums have been returned to the clerk, new prints will be made, all obsolete prints will be picked up and replaced in accordance with the distribution list on the vellum card. One copy of the obsolete drawing will be placed in an obsolete storage and the remaining copies will be destroyed.

The main feature of this system is simplicity while maintaining complete control over the handling of engineering drawings. The system can be adapted to more elaborate requirements, such as routing through channels, control of outside production prints, and practically any other engineering department requirements.

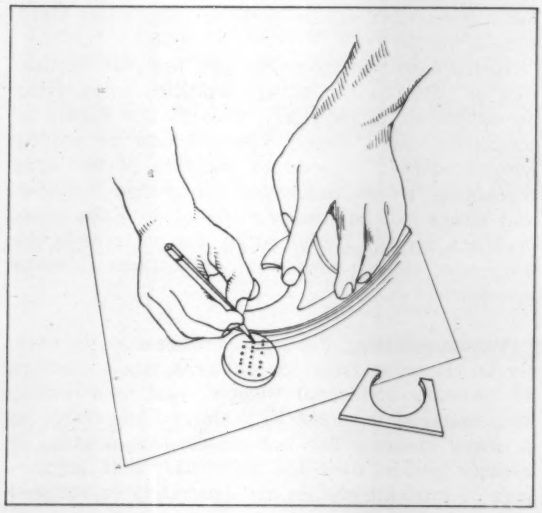
Tips and Techniques

Format Drawing

Sometimes, a drawing format, title block, or similar element must be drawn often, but not frequently enough to warrant printed formats or adhesive labels. In such cases, the format may be drawn on the linoleum or paper drawing-board cover with India ink. The lines can be easily traced onto the drawing when needed.—JOHN G. STEFFEY, *W. H. Reisner Mfg. Co. Inc., Hagerstown, Md.*

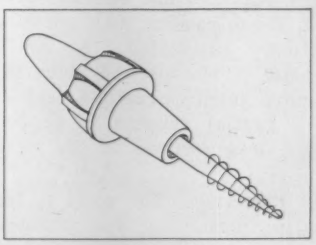
Drawing Parallel Lines

For tracing irregular, curved lines, the center disc from an Ames lettering device may be used. The wide selection of holes on the disc will usually provide one that can be used. Frequently a greater range can be obtained than by the use of a regular parallel-line tracer.—L. E. REICHENBAUGH, *American Airlines Inc., Overhaul and Supply Depot, Tulsa, Okla.*



Preventing Ink Bubbles

Annoying bubbles form on the ink dropper when drawing ink from a partially emptied bottle. These bubbles are likely to burst—spattering ink over the



drawing. The bubble problem can be eliminated—or at least reduced—by placing a short length of No. 23 bare copper wire about $\frac{1}{8}$ in. into the end of the dropper. The excess wire is coiled around the shank of the dropper.—HERBERT L. BROWN, *Hoover Co., North Canton, Ohio.*

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables or photos to: Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

Copper-base and aluminum alloy parts, cast in plaster molds under vacuum, have unusual physical characteristics plus sharp detail and high dimensional accuracy. This article describes the process and how to use it when designing intricate, high-strength castings.

Fig. 1 — High reproduction of surface and internal features results from "pulling" metal into the mold cavity by vacuum. Pump intake port is cast in high-strength manganese bronze; disc portion is 3⅛ in. diam by 1/16 in. thick at the rim.

Designing

VACUUM PLASTER-

VACUUM, applied to plaster-molds, produces castings with unusual physical properties without sacrifice of intricate detail or close dimensional tolerances. To avoid oxidation of the alloys, pouring is done at reduced temperatures. Rapid solidification results, producing a close-grained, dense casting with porosity and inclusions virtually eliminated. At low temperatures, the metal is viscous and sluggish. Therefore, to achieve intricate details and close configurations, a partial vacuum is applied around both cope and drag sections of the mold.

Molds and Patterns: The mold is highly permeable plaster, permitting the reduced atmosphere to occur in the mold cavity, literally pulling the metal into place. Also, the application of vacuum to the mold evacuates any steam or gases that may have been formed in pouring, minimizing porosity.

High-production methods employed develop high-quality castings at costs lower than investment castings on the whole, and comparable to sand castings in some instances. Patterns are highly polished engraver's brass, mounted on brass plates. Flasks are subdivided into 1-in. increments for the 18-in. length. The 10-in. width is divided in half by the runner going down the center to the sprue. With this system, a small or large space in the flask may be used, dependent on production requirements. For short runs or prototype work, a pattern placed in the flask in this way may share space with several other patterns that are to be poured in the same alloy. Sharing initial mold costs with others permits economical short runs of parts.

To increase casting production, low-cost duplication of patterns can be accomplished to as great an extent as is required. Due to the nature of tooling involved, design changes can be readily accommodated. The brass patterns permit easy machining where necessary for design changes, and pieces can be readily soldered onto the brass or fillets added. Initial outlay for patterns is the final cost, since replacement of patterns is never necessary.

Vacuum-Casting Process: Impressions, or plaster molds made from the patterns, are a mixture of ordinary industrial plaster, talc, and water. This material is mixed in a slurry comparable to a heavy cream. The hot plaster-talc mixture is gravity poured over the patterns. Fine engravings or intricate shapes are accurately reproduced

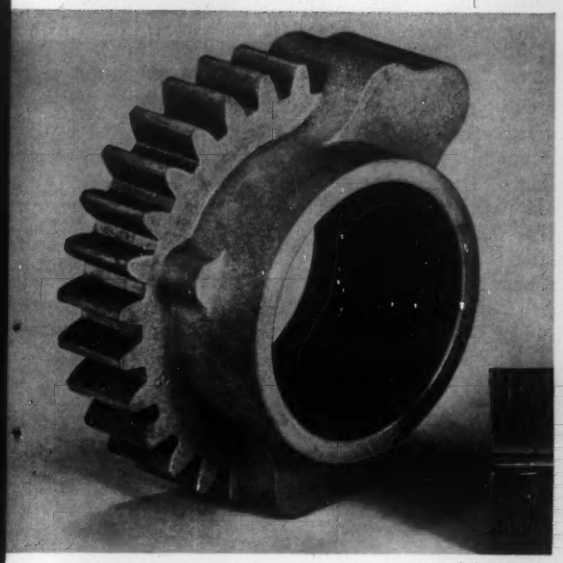


Fig. 2—Left—As-cast gears frequently require no machining except for reaming hub hole. XX manganese-bronze gear has 1/2-in. wide by 0.131-in. thick teeth.

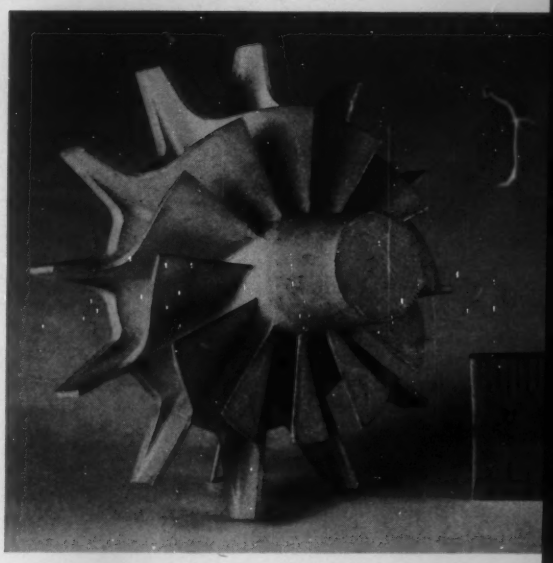


Fig. 3 — High-density vacuum castings, with high dimensional accuracy, permit cast impellers for speeds to 30,000 rpm. Concentricity of leading edges is held to within 0.005 in. Impellers up to 24 in. diam may be vacuum cast.

MOLD CASTINGS

By W. G. WILKINS
President
Universal Castings Corp.
Chicago, Ill.

in the plaster mix as it solidifies. The mixture sets rapidly and is extracted from the flask when it can support its own weight. Cope, drag, and cores are baked to drive off all free water and water of crystallization, so that no moisture is present when metal is poured into the completed mold. The baked molds are permeable, permitting vacuum to be applied while pouring the metal. Cores are made of the same material.

Castings poured into these dehydrated-plaster cope and drag sections are not scratched or nicked when broken out of the plaster. Any plaster that may adhere to the casting is washed away with a high-pressure water jet. The "as cast" surfaces produced range from 45 to 80 mu in. rms finish.

Mechanical Properties of Vacuum-Cast Alloys

Alloy	Minimum Tensile Strength (psi)	Minimum Yield Point (psi)	Elongation in 2 in. Gage (%)	Brinell Hardness
No. 10 Brass	50,000	25,000	15	83-110*
No. 20 Aluminum bronze.	83,000	30,000	9	150-195†
XX Manganese bronze....	95,000	60,000	5	165-210†
22% Nickel brass	50,000	47,000	3	150-185†
High-strength aluminum..	36,000	25,000	2-3	63-95*
Silicon aluminum bronze..	59,000	29,000	15	116-137†

*500 Kg load
†3000 Kg load

Metal shrinkage, distortion and warpage is negligible.

Intricate Shapes: In torque-converter and impeller work, complex and intricate blade configurations can be accurately reproduced in both shrouded and open types. The method used employs solid one-piece plaster cores and cast-iron molds to produce castings to close dimensional tolerances for blade spacing, configuration and angularity. There are no parting lines on either leading or trailing edges of blades. No misalignment of spacing or racking of core sections can occur. Smooth surfaces produced eliminate need for internal polishing or machining. Expensive balancing of the wheels is minimized through accurate distribution of weight due to uniform thickness of the blades. Blade sections can be cast to a knife edge with shrouds as thin as 1/32 in., or with no shroud at all.

Materials Cast: A wide variety of alloys may be vacuum cast. All are copper-base alloys with the exception of No. 356 Aluminum. Lowest in cost, and most extensively used, is No. 10 yellow brass, comparable in specification to most commonly used brass metals. Good physical strength can

Fig. 4—Aluminum alloy 356-T6 may be cast to sections as thin as 1/32 in. High accuracy permits precision mating of pairs for aluminum latch housing.

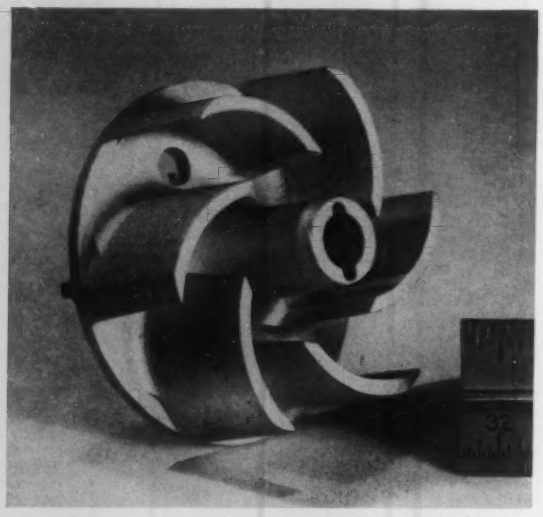
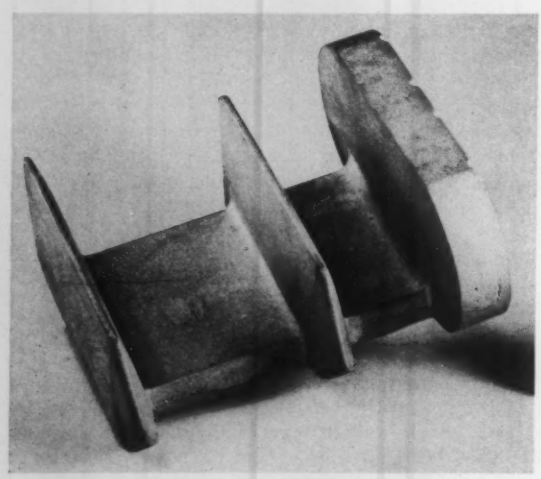


Fig. 5—Above—No. 10 brass is readily cast into precision parts with sharp corners, thin sections, and intricate contours. Finish is between 60 and 90 mu in. rms.

Fig. 6—Below—Cast electrolytic copper has minimum conductivity of 90 per cent. Parts have good dimensional accuracy with no inclusions or porosity.



be achieved with this alloy and its toughness is rated above bearing brass. Machinability is good.

One of the highest-strength materials for vacuum casting is manganese bronze XX. This alloy has a minimum tensile strength of 95,000 psi and a yield strength of 60,000 psi. Hardness averages 190 Brinell. The alloy has unusual wear-resisting characteristics and is used where stress concentrations are high. Ductility is low. Machinability is not as good as yellow brass but, with the use of carbide tools, machining is not difficult. Corrosion resistance is good.

Aluminum bronze, another alloy available for vacuum casting, has a tensile strength of 83,000 psi and a yield of 30,000. Ductility for this alloy is higher than manganese bronze. It is an unusually tough alloy and has high resistance to shock and impact loads. Corrosion resistance is good and wear qualities are excellent. Like manganese bronze, it is machined with carbide tools.

One of the alloys most frequently used in the food-processing industries is a 22 per cent nickel brass, commonly known as "dairy metal." Due to the smooth surface produced by plaster-mold vacuum casting, little polishing is required. When polished, the finish of this metal blends well with stainless steel. The dense cast surface, when highly polished, eliminates porosity where bacteria might lodge. Corrosion resistance is excellent.

Vacuum-cast aluminum conforms to AMS 4217B, 4260B, and ASTM B 26-52T. Minimum tensile of 36,000 psi with a yield of 20,000 psi can be obtained in test bars; averages far exceed these properties. Castings of this material readily pass 100 per cent x-ray inspection.

Beryllium copper, cast under vacuum, can be heat treated after casting to a tensile strength ranging to 165,000 psi with yield strength to 145,000 psi. With proper heat treatment, Brinell hardness can be between 400 and 440.

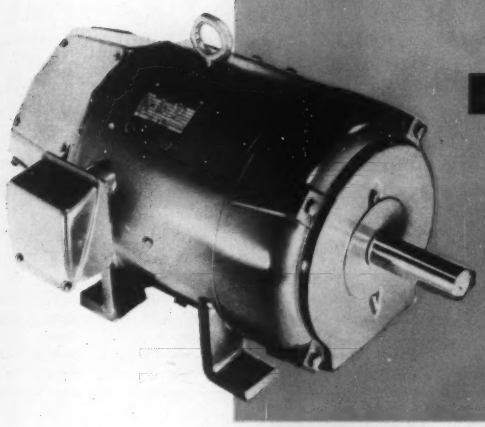
Finishes and Tolerances: All vacuum-cast alloys have an as-cast surface finish of between 65 and 85 mu in. rms except for the area where the gate is removed. Typical gate-removal methods produce a finish of about 125 mu in. rms.

General tolerances are usually recommended as ± 0.005 in. for the first inch with 0.003 in. for each additional inch. Tolerances across the parting line average ± 0.010, with a possible shift of 0.015 at the parting line. In many cases, the pattern is built "up" or "down" to bring the parting line into an area where possible shift is not detrimental. Also, a special core can be used to bridge across the parting line. Such a core aligns the mold halves, giving tolerances of ± 0.005 in.

Additional Reading

This article forms another part of our continuing coverage on producibility design of castings, as influenced by the various methods currently available. Earlier articles in Machine Design on casting design are:

Magnesium Castings ..... May 17, 1956
Designing Gray Iron Castings ..... January 10, 1957
Shell-Mold Castings ..... March 7, 1957
New Applications for Shell Castings (Abstract) ..... May 2, 1957
Investment Castings ..... August 22, 1957



Mechanics of Applying Electric Motors

By W. R. HARRIS
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Industry Engineering
Westinghouse Electric Corp.
East Pittsburgh, Pa.

SUCCESSFUL application of electric motors in design requires much more than data on motor design and operating characteristics. A thorough knowledge of fundamental mechanics is required. Such information is useful in calculating power requirements of various machines, interpreting power data, selecting flywheel characteristics, plotting duty cycles, and determining acceleration and retardation time, force and energy relationships.

In the analysis of drive systems the motor application engineer probably spends more time with fundamental mechanics than he does with electrical phenomena. It is just as important to find out accurately what the motor or drive system has to do, as it is to design a motor or drive system to perform specified functions. This problem is becoming more and more important as the speed and complexity of machines increase.

This article shows how the fundamental mechanics formulas in Table 1 are the basis for several formulas commonly encountered in making motor-load calculations. The fundamental formulas in Table 1 are based on the foot-pound-second system. Conversion to other distance-weight-time systems is illustrated.

Table 1—Fundamental Mechanics Formulas

	Rotation		Translation	
1a.	$E_k = \frac{J\omega^2}{2}$	2a.	$E_k = \frac{MV^2}{2}$
1b.	$E_w = T\theta$	2b.	$E_w = FD$
1c.	$J = \frac{WK^2}{g}$	2c.	$M = \frac{W}{g}$
1d.	$P_s = T\omega$	2d.	$P_s = FV$
1e.	$T_x = J\alpha$	2e.	$F_x = Ma$

Work and Power

Practically all of the steady-state and transient characteristics of the drive system comprising the motor and the driven machine can be developed by the use of formulas on fundamental mechanics, either alone or in combination with similar electrical data. The amount of work done, the rate of doing work, whether energy is stored or expended, and the ensuing torque, speed, and acceleration relationships can be determined from these basic formulas except for complex transient conditions.

To convert Equation 1*d* in Table 1 from foot-pounds per second units to horsepower simply involves the substitution of $2\pi N/[(60)(550)]$ for ω giving

$$P = \frac{TN}{5250}$$

where N is the rotational speed in revolutions per minute.

Similarly, to change Equation 2*d* in Table 1 to horsepower calls for the substitution of $S/33{,}000$ for V giving

$$P = \frac{FS}{33{,}000}$$

where S is the translation speed in feet per minute.

Of course, any other distance-weight-time sys-

tem could be employed by changing the values of the constants.

Torque and Acceleration Time

One of the most frequent problems encountered in motor application work is calculating the time required to accelerate a motor and the machine it drives. One example of an interesting motor-acceleration problem is shown in Fig. 1. The formula for acceleration time can be derived, if the acceleration torque is assumed to be constant, by remembering that the acceleration torque is the product of inertia and the rate of acceleration as given in Equation 1*e*, and that the difference in speed in radians per second is equal to the product of acceleration and time, or

$$\omega_1 - \omega_2 = \alpha t$$

The acceleration value α, calculated from the preceding equation and substituted in Equation 1*e*, gives

$$tT = J(\omega_1 - \omega_2)$$

or, as commonly encountered in motor-application problems

$$t = \frac{WK^2(N_1 - N_2)}{308\,T_x}$$

Fig. 1—Tire-testing machine that requires over 30 min to accelerate to full speed. The tire brakes the machine to a stop in a few seconds to simulate the landing of a large airplane. Fundamental mechanics formulas are required to calculate the acceleration forces which determine the motor rating. The combined flywheel and motor WK^2 is 10,000,000 lb-ft^2. The motor has a rating of 400 hp at 350 rpm and 6000 lb-ft torque.

Similarly, the formula for translation acceleration time in more commonly used engineering terms is

$$t = \frac{W(S_1 - S_2)}{1932\,F_x}$$

Limitations of this formula should be carefully noted. Constant acceleration torque is assumed in its derivation, but if the acceleration torque is not uniform, which is usually the case, an error is introduced. The error is small for small torque variations, and by breaking up the speed-torque curve into segments and calculating the time for each segment, the total time can be calculated

Table 2—Acceleration Time Calculation for Nonuniform Torque

Step	Speed Range (rpm)	Difference Speed (rpm)	Avg. Motor Torque (lb-ft)	Load Torque (lb-ft)	Avg. Accel. Torque (lb-ft)	Accel. Time (sec)
1	0/1000	1000	13.5	6.0	7.5	4.33
2	1000/1400	400	15.5	6.0	9.5	1.37
3	1400/1670	270	17.5	6.0	11.5	0.76
4	1670/1715	45	15.7	6.0	9.7	0.15
5	1715/1730	15	13.1	6.0	7.1	0.07
6	1730/1750	20	10.4	6.0	4.4	0.15
					Total =	6.83

Nomenclature

a = Acceleration, ft per sec per sec
D = Distance, ft
E = Voltage, v
E_k = Kinetic energy, ft-lb
E_w = Work, ft-lb
e = Base of Naperian logarithms, approx. 2.7183
F = Force, lb
F_x = Accelerating force, lb
g = Acceleration of gravity, ft per sec per sec
H = Ratio of system stored energy in hp-sec to machine rating in hp
I_a = Motor armature-circuit current, amp
J = Moment of inertia, lb-ft per sec^2
K = Radius of gyration, ft
k_a = Motor constant denoting increase in applied voltage, v per sec
k_t = Motor torque-current constant, lb-ft per amp
k_v' = Motor voltage-rotation constant, v per rad per sec
L = Inductance, h
$M = W/g$ = Mass, lb-sec^2 per ft
N = Rotational speed, rpm
P = Power or rate of doing work, hp
P_s = Power or rate of doing work, ft-lb per sec
P_t = Stored energy power-time constant, hp-sec
R = Resistance, ohms
R_a = Motor armature-circuit resistance, ohms
S = Translation speed, fpm
T = Torque, lb-ft
T_o = Mechanical time constant
T_x = Acceleration torque, lb-ft
t = Time, sec
V = Velocity, ft per sec
W = Weight, lb
α = Angular acceleration, rad per sec per sec
θ = Angle of rotation, rad
ρ = Gear or belt ratio
ω = Angular velocity, rad per sec

very accurately. Friction, windage, and load reaction torques must be subtracted from the motor torque in order to obtain the torque available for acceleration.

Example 1: Consider the speed-torque curve of a squirrel-cage motor, Fig. 2. Assume a WK^2 of 10 lb-ft² and a constant friction or load torque of 6 lb-ft. It would theoretically take an infinite time to accelerate to the point where friction torque equals motor torque as the acceleration torques become progressively smaller. A method for calculating the time required to accelerate to 1750 rpm is shown in Table 2.

Transfer of WK^2 between Shafts

Motors are often geared or belted to the driven machine, and parts of the same machine may run at widely different speeds. It is desirable to get the equivalent WK^2 of the entire system at one point—usually at the motor shaft. This is accomplished by correctly assuming that the stored energy transferred will remain the same, and speed and WK^2 will be changed to suit. Thus in the foot-pound-second system

$$\frac{J_1 \omega_1^2}{2} = \frac{J_2 \omega_2^2}{2}$$

By rearranging terms

$$J_1 = J_2 \left(\frac{\omega_2}{\omega_1} \right)^2$$

Or in the foot-pound-minute units

$$(WK^2)_1 = (WK^2)_2 \left(\frac{N_2}{N_1} \right)^2$$

$$= (WK^2)_2(\rho)$$

Since the ratio of speed is the gear or belt ratio, it follows that the transfer of WK^2 varies as the square of the gear ratio, or the reciprocal of the square of the gear ratio, depending on whether the transfer is made from a high to a low-speed shaft or vice versa.

Example 2: Assume that it is necessary to calculate the WK^2 at the motor shaft for a motor driving a pair of press rolls through a two-step gear, Fig. 3. Motor speed N is 1800 rpm and its

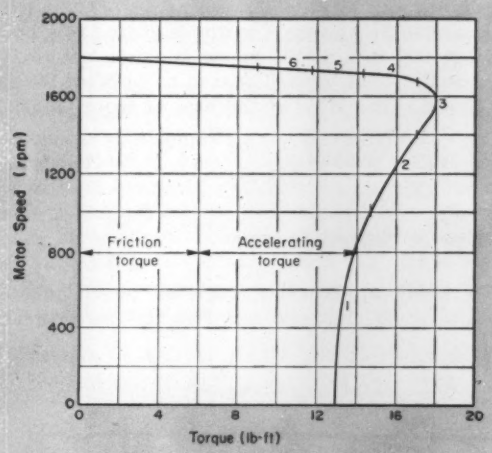


Fig. 2—Typical speed-torque curve of squirrel-cage induction motor illustrating acceleration time calculations when torques are nonuniform.

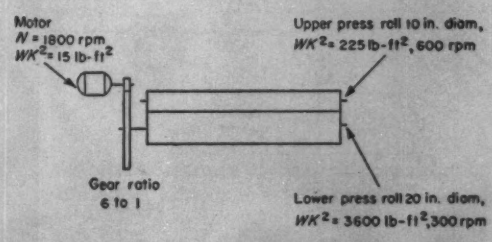

Motor
N = 1800 rpm
WK² = 15 lb-ft²
Upper press roll 10 in. diam,
WK² = 225 lb-ft², 600 rpm
Gear ratio
6 to 1
Lower press roll 20 in. diam,
WK² = 3600 lb-ft², 300 rpm

Fig. 3—Sketch of motor, speed-reducer gears, and press rolls for hypothetical problem in Example 1.

Fig. 4—Overhead crane for handling heavy steel coils. Fundamental mechanics in rotation and translation is highly important in selection of motor ratings to meet the duty cycle imposed in this application.

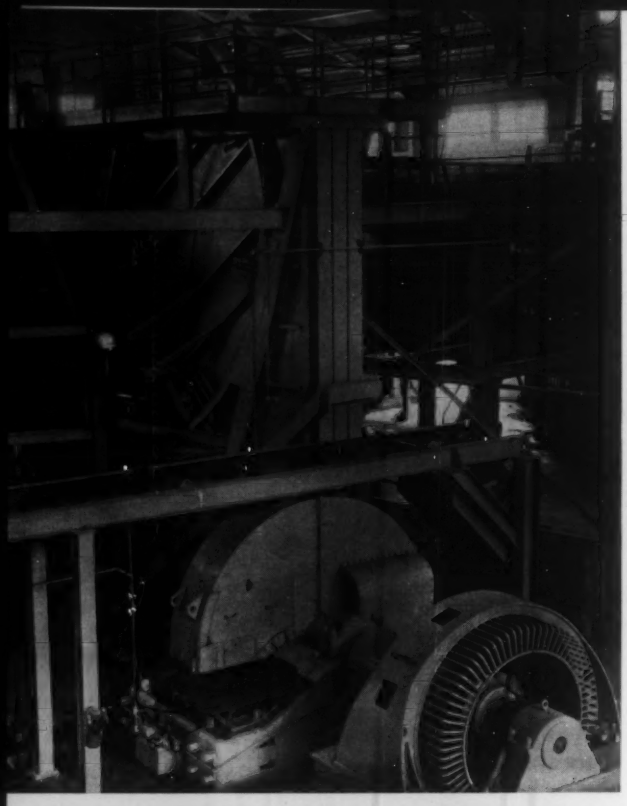


Fig. 5—Large log-chipper installation which produces chips for making paper. Logs are fed down the chute and fall against the chipper disc which has radial knives bolted to it. This chipper can reduce a 4-ft long log to ¾-in. chips in less than 1 sec.

WK^2 is 15 lb-ft². The gears have a ratio of 6 to 1. The lower press roll is 20 in. in diameter with a WK^2 of 225 lb-ft² at 600 rpm. The upper press roll is 10 in. in diameter with a WK^2 of 3600 lb-ft² at 300 rpm.

The total WK^2 at the motor is calculated by determining the WK^2 each press roll produces at the motor and adding it to the motor WK^2.

The WK^2 of the lower press roll at the motor = $3600\ (300/1800)^2 = 3600\ (1/6)^2 = 100$ lb-ft². The WK^2 of the upper press roll at the motor = $225\ (600/1800)^2 = 25$ lb-ft². These values for WK^2 of the rolls added to the motor WK^2 gives a total $WK^2 = 140$ lb-ft².

Equivalent WK^2 of Bodies in Translation

Bodies, such as planer beds, elevators, log carriages, and cranes and hoists, have straight-line motion. They are connected to the driving motors by either rack and pinion or cable attached to drums, Fig. 4. Such drives may be required to meet rigid duty cycles, and careful evaluation of WK^2 is necessary to determine accelerating and decelerating torques and times.

To obtain an equivalent WK^2 at the motor shaft, equate the stored energies and solve for the WK^2 as follows:

$$\frac{J\omega^2}{2} = \frac{MV^2}{2}$$

$$\frac{WK^2}{2g}\left(\frac{2\pi N}{60}\right)^2 = \frac{W}{2g}\left(\frac{S}{60}\right)^2$$

$$WK^2 = W\left(\frac{S}{2\pi N}\right)^2$$

Example 3: Assume a motor is geared to a hoist so that 900 rpm at the motor is equivalent to 100 fpm at the hoist hook. The load to be lifted weighs 10,000 lb. The WK^2 of the load at motor shaft is

$$WK^2 = 10{,}000\left(\frac{100}{2\pi(900)}\right)^2 = 3.14 \text{ lb-ft}^2$$

Use of Stored Energy

In many applications, such as punch presses, shears, wood chippers, and flywheel motor-gener-

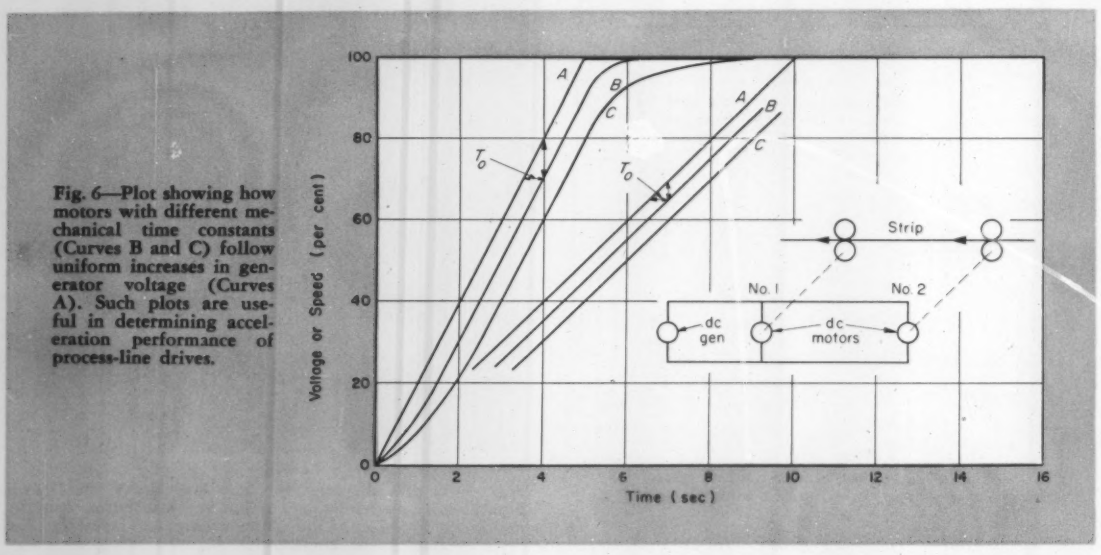


Fig. 6—Plot showing how motors with different mechanical time constants (Curves B and C) follow uniform increases in generator voltage (Curves A). Such plots are useful in determining acceleration performance of process-line drives.

ator sets, heavy flywheel effect is used. It is often convenient to calculate the stored energy in terms of horsepower-seconds. Since the change in stored energy is equivalent to the work done, the horsepower-seconds for a system in rotation are

$$P_t = \frac{J\omega_1^2}{2(550)} - \frac{J\omega_2^2}{2(550)}$$

$$= \frac{WK^2(N_1^2 - N_2^2)}{3{,}231{,}000}$$

Example 4: A typical chipper, Fig. 5, used in the paper industry has a WK^2 of 130,000 lb-ft^2, is operated at 375 rpm, and from power data it is known that 1620 hp-sec are required to chip an oak log 4-ft long and 14-in. in diameter. The torque of the wound-rotor induction-type drive motor is small compared to the load torque and can be neglected. By use of stored energy, it is simple to calculate how much the system will slow down when chipping one log. The stored energy in the chipper disc is $130{,}000\ (375)^2/3{,}231{,}000 = 5660$ hp-sec.

The energy remaining after the cut will be $5660 - 1620 = 4040$ hp-sec. Since the stored energy varies as the square of the speed, the per unit speed after the cut will be the square root of (4040/5660) or 0.845. The speed $N = 0.845\ (375) = 317$ rpm.

This is a much simpler method of calculation than obtaining load torque and using the deceleration formula. Also, when working with complex duty cycles, such as those encountered in rolling-mill applications, the use of stored energy results in considerable simplification of calculations.

Another useful relationship is the constant H, which is the ratio of system stored energy to machine rating. It can be expressed either in horsepower seconds per horsepower, or kilowatt-seconds per kilowatt. It is useful to know that $2H$ is equal to the accelerating time from zero to rated speed at rated torque.

Example 5: Assume that a 250-hp motor with a full-load speed of 375 rpm drives the chipper in Fig. 5. Full-load torque is

$$T = \frac{5250\,P}{N}$$

$$= \frac{5250(250)}{375} = 3500 \text{ lb-ft}$$

Time to accelerate is

$$t = \frac{WK^2\,N}{308T}$$

$$= \frac{130{,}000(375)}{308(3500)} = 45.2 \text{ sec}$$

Since the stored energy in the chipper in Fig. 5 as calculated in Example 4 was found to be 5660 hp-sec,

$$H = \frac{P_t}{P}$$

$$= \frac{5660}{250} = 22.6$$

Therefore, the time to accelerate is

$$t = 2H = 2(22.6) = 45.2 \text{ sec}$$

which checks with the other time value calculated in this example.

Mechanical Time Constant

In system drives where motors must be accelerated in step to avoid tearing material, an understanding of the "mechanical time constant" of the drive motor is necessary. If a dc motor is suddenly thrown across a fixed voltage, the speed-time relationship is

$$\omega = \frac{E}{k_v}\,(1 - e^{-t/T_o}$$

$$T_o = \frac{JR_a}{k_t\,k_v} = \frac{2HI_a\,R_a}{E}$$

$$E = I_a\,R_a + k_v\,\omega$$

$$T = J\alpha = J(d\omega)/(dt) = k_t I_a$$

The mechanical time constant T_o is directly analogous to the time constant of an inductive field structure, which is the inductance divided by the resistance, or, to electrical engineers, the familiar L/R. When a motor is thrown across the line, the inertia connected to it prevents immediate build-up of speed just as the inductance in a motor field prevents the immediate build-up of field current. The motor will reach 63 per cent speed at a time equivalent to the mechanical time constant.

The mechanical time constant is quite different from the time required to accelerate to full speed at full-load torque. Actually, the mechanical time constant can be calculated by multiplying the per unit resistance drop in the armature circuit at full load by the accelerating time from zero to full speed at full-load torque. Since the IR drop of most motors falls between the ranges of 3 per cent to 7 per cent, the average mechanical time constant is about 1/20 of the accelerating time.

If the voltage increases in proportion to time, such as occurs when accelerating an adjustable-voltage drive system, the speed-time relationship is

$$\omega = \frac{k_a}{k_v}\left[\, t - T_o(1 - e^{-t/T_o}) \,\right]$$

After the transient disappears, the motor speed lags behind the generator voltage by the mechanical time constant. This relationship is very useful in determining the accelerating performance of adjustable-voltage systems.

Curve A in Fig. 6 illustrates a uniform build-up of generator voltage for a 5-sec or a 10-sec period. If a motor had a zero mechanical time constant, such as would be obtained with zero armature-circuit resistance, it would follow the generator voltage exactly. An infinitesimal change in bus voltage would circulate the current needed

to develop the required accelerating torque, and the motor speed would follow the bus voltage without lag.

The B curves in Fig. 6 illustrate how a motor with ½-sec mechanical time constant follows the generator voltage. On the linear part of the curve (after the transient has disappeared), ½ sec on the time scale illustrates the lag in motor speed behind bus voltage. The C curves illustrate a 1-sec mechanical time constant, and show a further lag of motor speed behind bus voltage.

Consider that two motors are driving press rolls with paper, cloth, or steel strip between the rolls. If the strip is moving in the direction indicated in Fig. 6 and motor 1 has a longer mechanical time constant than motor 2, the strip tension will slack off during acceleration and a loop may be formed. If motor 2 has the longest mechanical time constant, motor 1 will try to get ahead and will cause an increase in strip tension. Of course, this increase in tension will help to accelerate motor 2, and the system will stay in step until the tension exceeds the breaking point of the material.

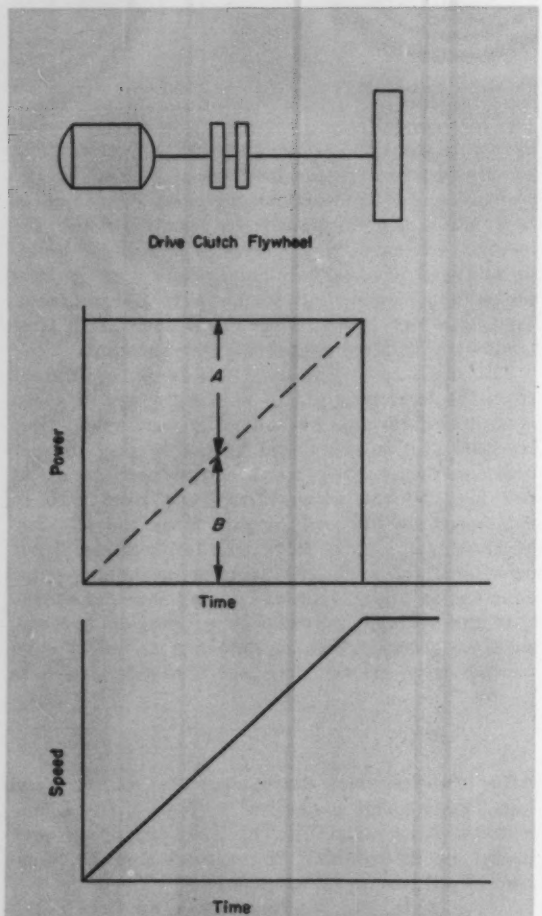


Fig. 7—A friction-clutch analogy is useful in determining the acceleration losses in slip-type devices, such as clutches, squirrel-cage rotor motors, brakes, etc.

The vertical distance between the curves illustrates how far in speed each motor will lag behind the generator voltage if unrestrained by material. For the B curve and a 5-sec acceleration, the lag is 10 per cent; for a 10-sec acceleration the lag is only 5 per cent. This illustrates that the greater the acceleration the greater the difference between bus voltage and motor speed, and the greater the difference between motors of different mechanical time constants.

Quite frequently the accelerating load can equal or exceed the normal load, and the designer must pay careful attention to the mechanical time constant if the drive is to be successful. By using the mechanical time constant relationship to plot acceleration curves, it is relatively simple by "cut and try" to find the increase or decrease in tension under acceleration or deceleration conditions. For a 5-sec acceleration assume mechanical time constants of ½ and 1 sec for motors 1 and 2, respectively, and duplicate motors with 5 per cent armature-circuit resistance. The 10 per cent difference in motor countervoltage and speed will be equalized by increased strip tension. To make the speeds the same, the countervoltage of the No. 1 motor would drop 5 per cent and the countervoltage of motor 2 would rise 5 per cent. This would cause an increase in strip tension equivalent to full load on motor 1. Since operating tensions seldom exceed 25 to 50 per cent of motor load, this results in an appreciable increase in tension. If the mechanical time constants were matched, there would be no change in tension during acceleration.

Acceleration Losses in Slip-Type Devices

In any slip-type device, such as a clutch, eddy-current coupling, hydraulic coupling, or squirrel-cage motor, the energy loss is appreciable during acceleration. Actually, the loss bears a direct relationship to the energy stored in the system at full speed. The amount of loss can be easily proved mathematically, but it is somewhat simpler to use a simple friction clutch analogy.

In Fig. 7 assume that the drive side of the clutch is driven at constant speed. Also, assume that the clutch slips at the same torque regardless of speed, and that there is no friction or windage load involved. Thus, all energy which flows to the flywheel will be stored in the flywheel.

At zero time the flywheel is not moving and no power flows to it. All of the power disappears as loss in the clutch faces. At one-half speed, one-half of the power flows into the flywheel as shown by the B dimension in Fig. 7, and one-half of the power is dissipated in slippage between the clutch faces, as shown by A. At full speed, the instant before acceleration stops, all of the power goes to the flywheel and no power is lost in the clutch face. At the end of acceleration the power drops

to zero and the speed levels out.

Thus the A area is proportional to the loss in the clutch faces, and the B area is proportional to the energy which is stored in the flywheel. Since these areas are equal, the loss in the clutch faces is equal to the stored energy in the flywheel.

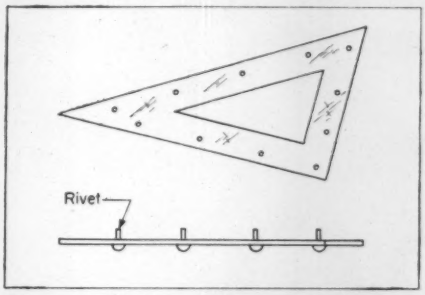
This solution is applicable to all slip devices, such as clutches, hydraulic couplings, squirrel-cage rotor motors, synchronous motors on starting, etc. For electrical motors, the solution gives rotor loss only; the stator loss must be added to obtain total motor loss.

It is also useful to know that if a squirrel-cage motor is plugged to a stop, the rotor losses are three times the stored energy. If a squirrel-cage motor is plugged to full speed in the reverse direction, the rotor losses are four times the stored energy. This can be proved by a similar analogy.

Tips and Techniques

Inking Triangle

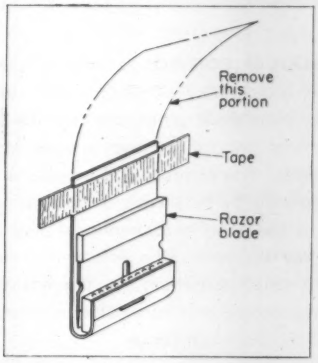
Ink smears from a triangle are usually avoided by elevating the triangle off the surface of the paper. A simple way to do this is by using rivets.



An advantage of this method is that the rivets need not be permanent—the triangle may be converted to pencil work again by simply removing them. Small holes are drilled in the template so that round-head rivets may be inserted. If the rivets are a snug fit into the holes, no additional method of retention need be provided.—DON EITZMANN, *Emerson Electric Mfg. Co., St. Louis, Mo.*

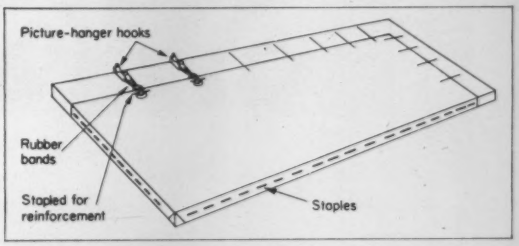
Razor-Blade Holder

A simple holder for a razor blade that protects both the blade and searching fingers, is made from a used paper-match book. Simply cut half the cover off and tape the remaining portion of the cover inside the drafting-table or desk drawer. The razor blade is inserted between the match stubs.—ALBERT W. OSSMANN, M.E., *American Machine & Foundry Co., Greenwich, Conn.*



Drawing Board Cover

On large boards where use and changing humidity cause paper board covers to loosen, and on small boards where handling causes frequent looseness, the cover can be kept under proper tension by rubber bands. Two edges of the cover should be securely stapled (or taped) to the board. Along the opposite two edges, a series of holes is punched. The holes should be reinforced with gummed rings and/or staples, depending upon the size of the cover. A row of picture-hanger hooks is located along two edges of the drawing board, to correspond with the holes in the cover. Tension is maintained by looping rubber bands through the holes in the cover and hooking them over the picture-hanger hooks.—BLAISE D'ANKA, *Cleveland.*



Areas Between Circles

The areas between concentric circles can be quickly found by using the equation $A = 2\pi R_3 (R_1 - R_2)$. In the equation, R_1 is the larger radius, R_2 is the smaller radius, and R_3 is the average of the two radii.—JESSE ROTH, *electrical engineer, Curtiss-Wright Corp., New York.*

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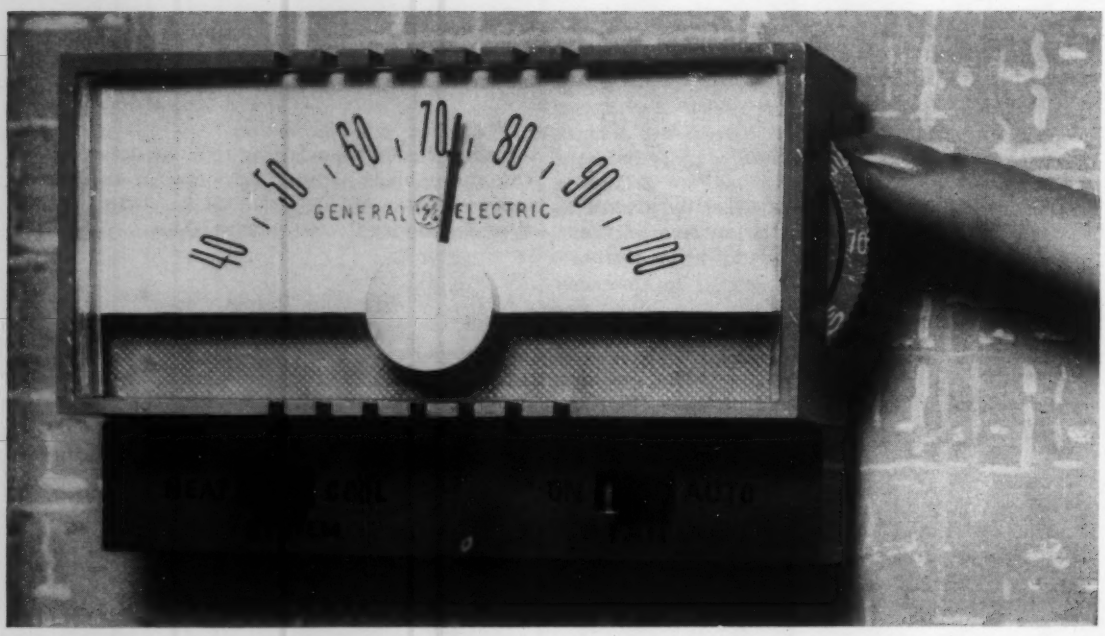
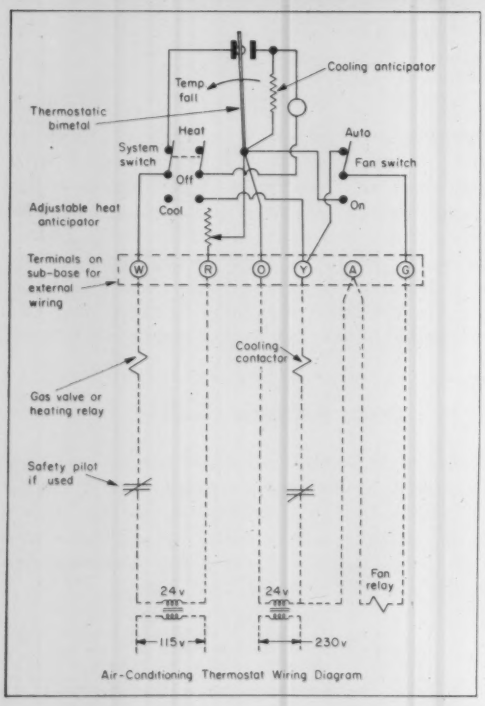
Thermostat Is Designed with Large Numerals and Square Lines



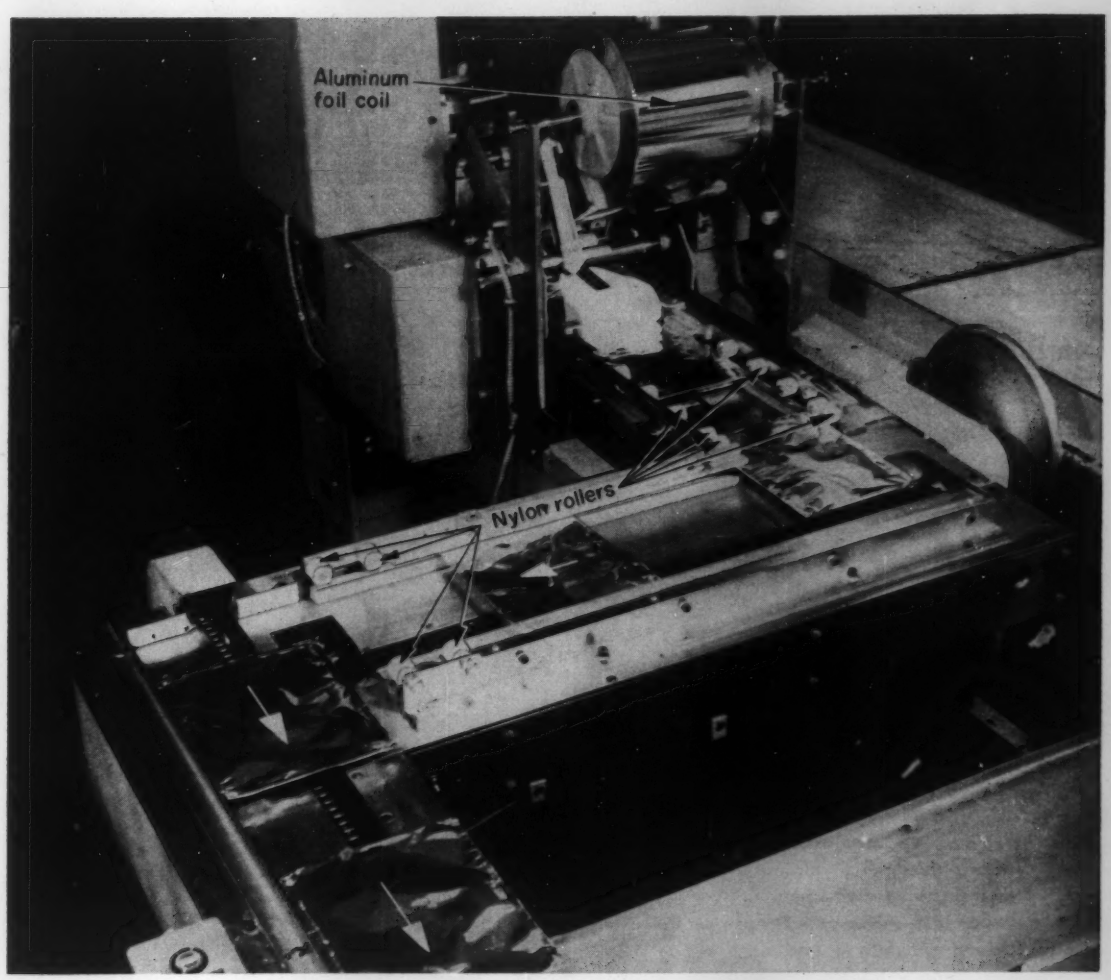


Air-Conditioning Thermostat Wiring Diagram

AN EASY-TO-READ ROOM THERMOSTAT has been designed with contemporary straight-line appliance styling by General Electric. Developed for use in domestic heating and air-conditioning systems, the new temperature sensing and control unit features bold-face temperature-indicating numerals that are visible from across an average-size room. The functional base attachment mounted directly under the thermostat is used for controlling cooling, heating and fan units. One switch in the base turns the air-conditioning, heating and cooling unit "on" or "off." The other is an "on" or "automatic" position switch for the fan.

CLOSER TEMPERATURE CONTROL is accomplished with an adjustable heat anticipator, a comfort dial, and a night setback resistor. The heat anticipator can be adjusted to provide proper heat anticipation over a wide range of control-circuit currents. The comfort dial lengthens or shortens the period of running by increasing or decreasing the effect of preheat. For use with a conventional time switch, the night setback resistor raises the effective temperature at the thermostatic strip, permitting the thermostat to hold a lower room temperature and eliminates the need for a second thermostat for the night range.

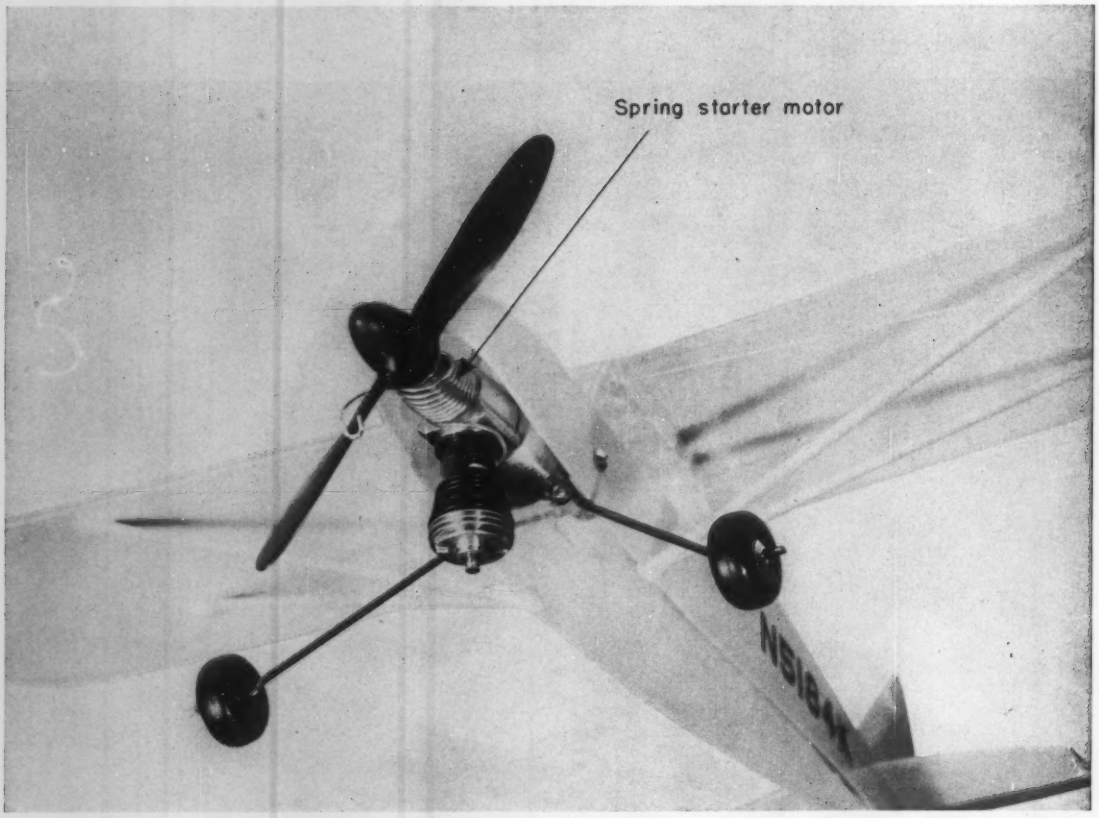
High-Speed Metal Crimping with Plastic Rollers



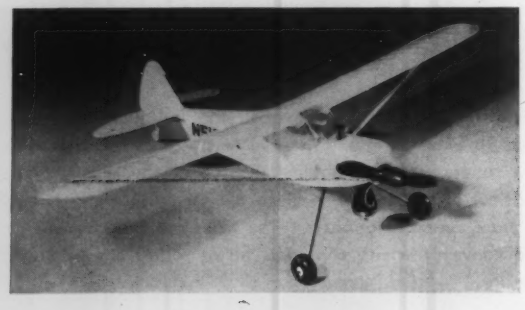
APPLYING ALUMINUM FOIL top sheets to open rectangular containers at high speeds is accomplished with a new machine developed by the Foil Kraft Div. of Kaiser Aluminum and the Scandia Mfg. Co. The Foilcrimp wrapping machine is designed to operate at speeds between 30 and 60 rectangular trays per minute, with savings in labor up to 85 per cent over hand-crimping techniques.

In operation, as the containers move along the conveyor, the foil top sheets are applied from the coil and trimmed to exact length. The foil is curled under the container rims, and a series of nylon rollers, pressing against the top of the rims, crimps the foil tightly and uniformly. First set of nylon rollers, which are mounted along edges of conveyor belt, crimps foil into place on sides of trays. The trays are then moved at right angles sidewise by a second conveyor where a second set of rollers crimps ends, making a secure and uniform closure.

One-Piece Plastic Plane

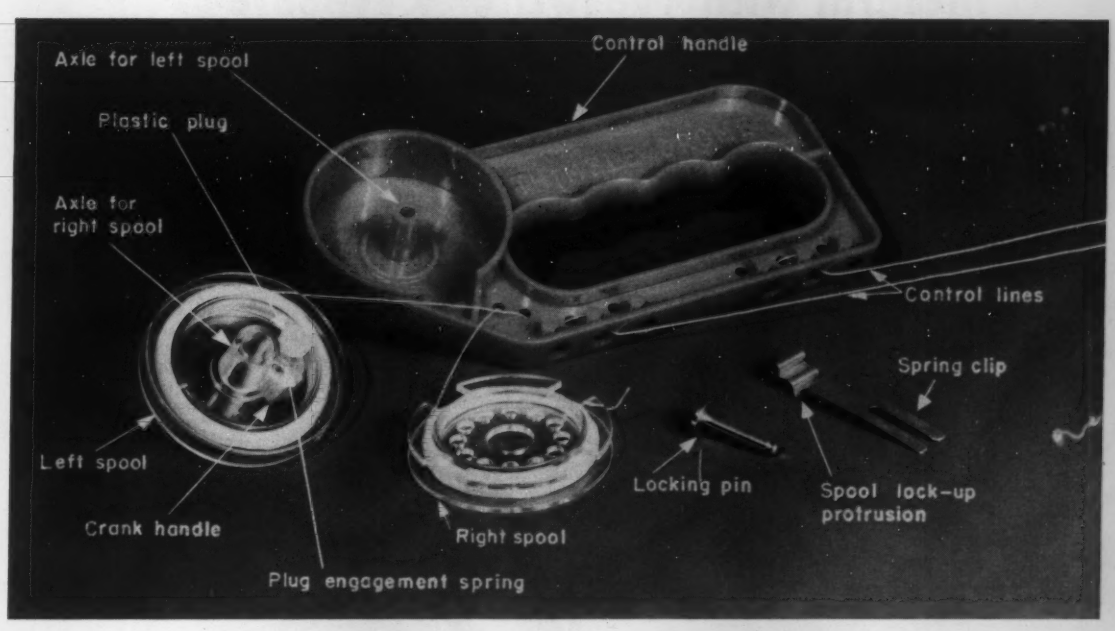


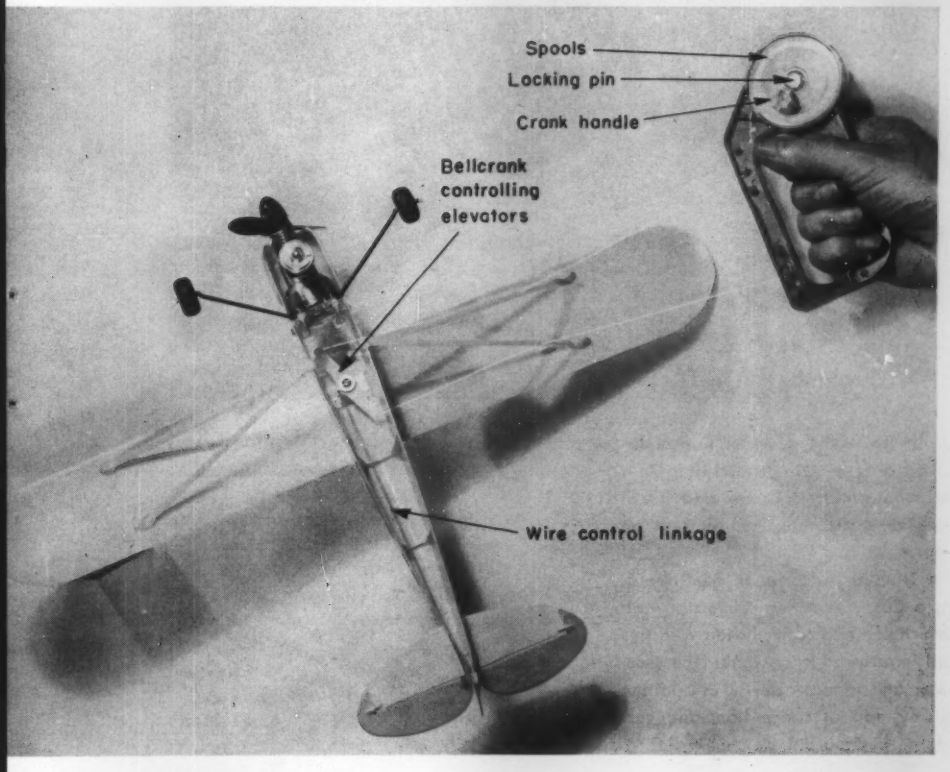
AUTOMATIC STARTING of the Thimble-Drome Super Cub 105 model plane is accomplished with a simple torsion-spring motor. The spring starting motor is mounted around the propeller-shaft housing with one end wrapped around the motor cylinder member. The other end of the spring, which is free when not in use, remains clear of the propeller. When preparing to start the engine, the operator loops the hook-shaped end of the spring over one blade of the propeller, and turns the propeller one complete turn in the reverse direction. When the prop is released, spring action "kicks it over" rapidly for starting.



INTEGRAL BODY-AND-WING DESIGN simplifies fabrication of this control-line model made by the L. M. Cox Mfg. Co. Inc., Santa Ana, Calif. Except for the windows, struts and movable elevators, the plastic plane is molded in one piece.

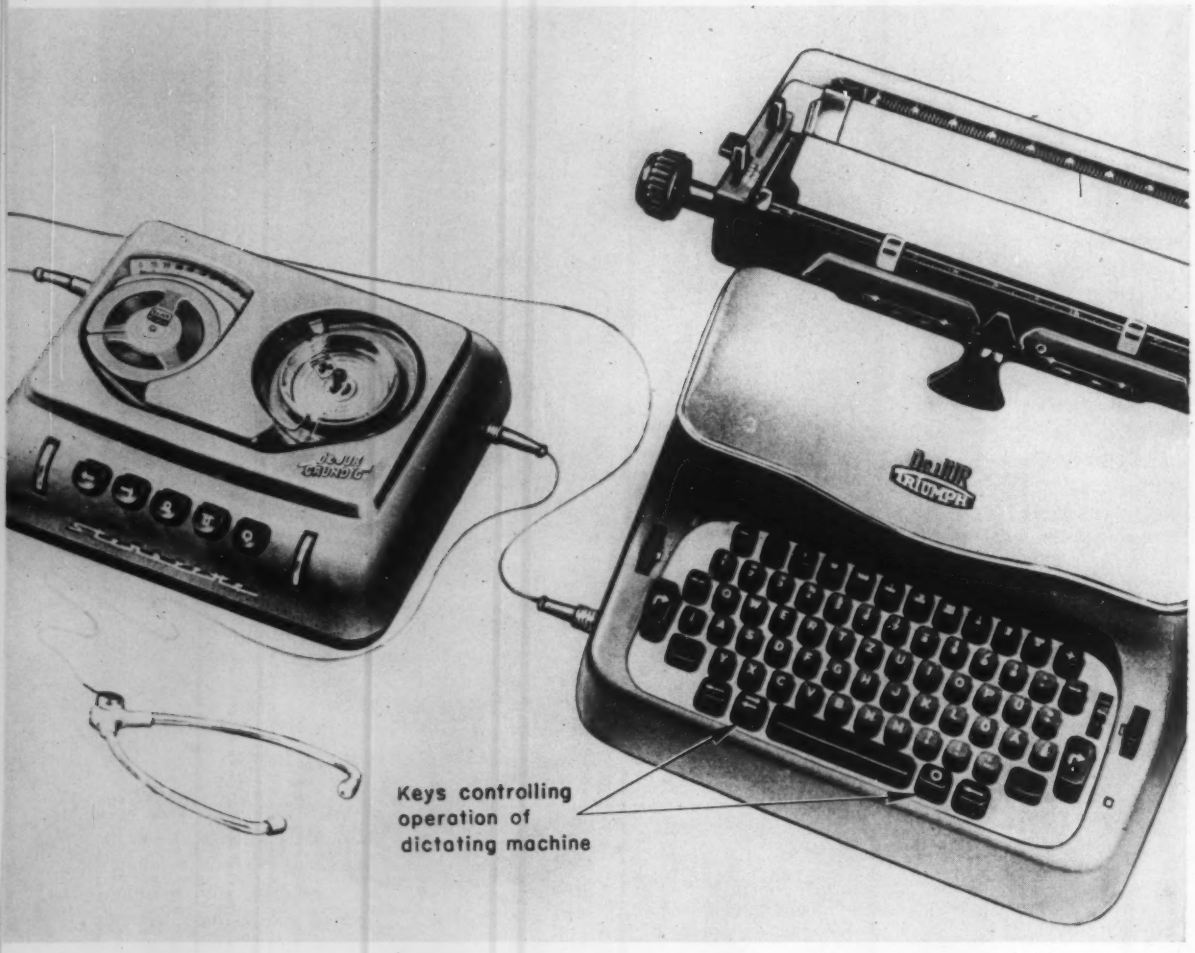
Has Automatic Starter





DUAL-SPOOL CONTROL REEL is made primarily of plastic. Spools are locked in relation to each other with a spring-loaded plastic plug member in the left spool which engages one of twelve round holes in the right spool. The plug is integral with the crank handle. Four squared notches in the right spool permit locking both spools in relation to the control handle. Spools are secured to the control-handle spool axle with a locking pin and spring clip. A protrusion on the spring clip also engages the rectangular notches in the right spool to effect lock-up of spools.

Transcriber Controls Are Integral with Typewriter Keyboard



"WIRED FOR SOUND," the new DeJur-Triumph typewriter line is designed to permit operation of a dictating system transcribing unit from the typewriter keyboard area. Starting, stopping and backspacing of Stenorette dictating machine is accomplished by keys on either side of typewriter space bar.

The typewriter is built by the Triumph factories in Nurenberg, West Germany, for the DeJur-Amsco Corp. Automatic injection and ejection of paper and envelopes, which can be accomplished with this new typing machine, reduce overall letter-production time. The electric machine has a repeat backspacer and repeat asterisk in addition to the usual repeat underscoring key, repeat space bar, and carriage-return keys on either side of the keyboard.

Often overlooked, practical fundamentals of three sorts influence proper design of

IDLER GEARS

- **Location**
- **Stress analysis**
- **Mounting**

By THOMAS BARISH
Consulting Engineer
Cleveland

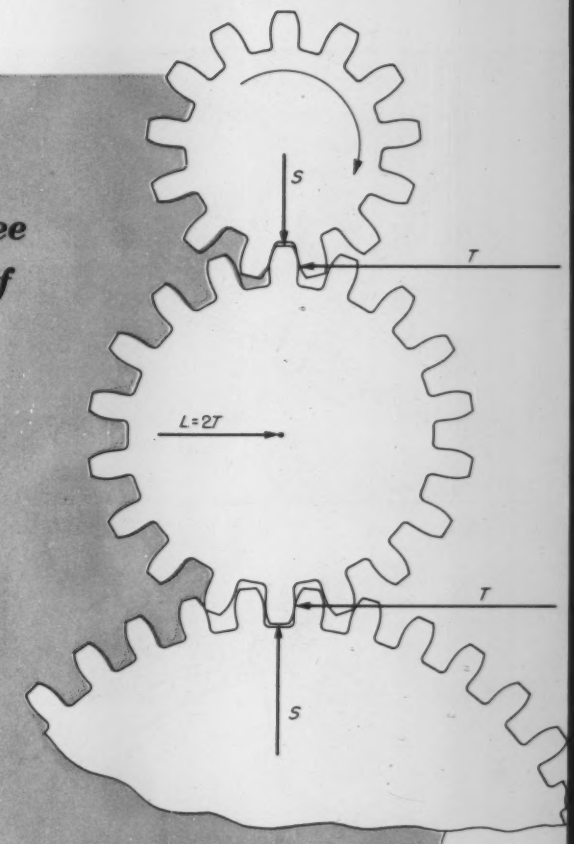
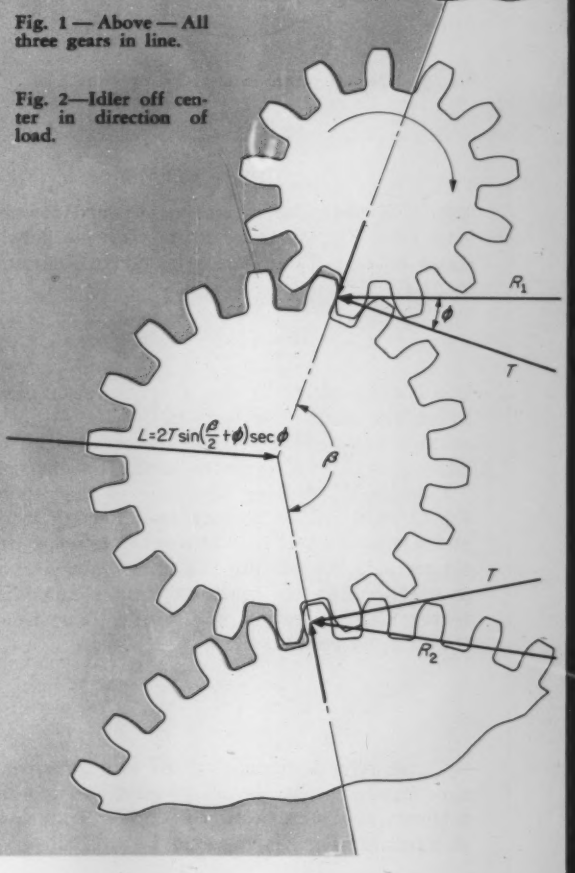


Fig. 1 — Above — All three gears in line.

Fig. 2—Idler off center in direction of load.



SPUR-GEAR idlers are commonly used (1) when two parallel shafts are too far apart to be geared directly to each other, and (2) for reversal of rotation.

Position: Varying the position of the idler can make large differences in bearing and support leads, and hence also in rigidity of support. Putting all three shafts in one line, Fig. 1, leads to the smallest possible idler and favors machining of housing bores. Total bearing load L is then $2T$, twice the tangential tooth load. Separating forces, S, cancel out. The separating forces are the smaller ones even though they frequently receive most attention. Note that the idler bearing and support loads are larger than those that would result on the main shaft if the main gears were directly mated.

Changing the idler size does not change the bearing loads or the linear velocity of contacting. Increasing the idler size only decreases the bearing speed and leaves more room for bearings inside the idler. It also reduces the frequency of stressing on any one tooth.

Bearing and housing loads can be radically changed by moving the idler off to one side, which usually also calls for an increase in idler

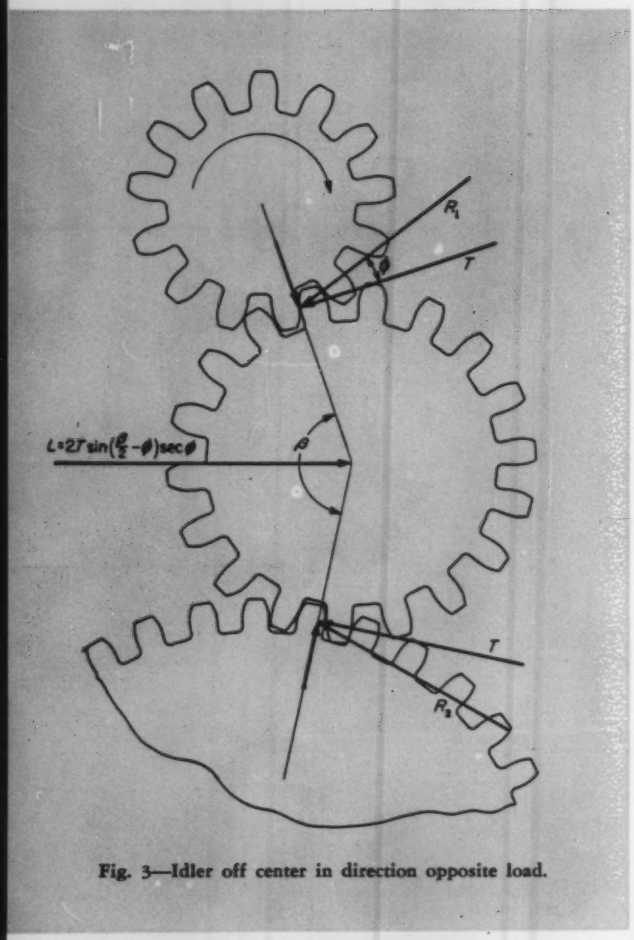


Fig. 3—Idler off center in direction opposite load.

size. If the idler is moved outward toward the load side, Fig. 2, these loads increase slowly because R_1 and R_2 are more nearly in line, and the load is

$$L = 2T \sin\left(\frac{\beta}{2} + \phi\right) \sec\phi$$

The loads peak at $2T$ sec ϕ, when the angle β between the shafts reaches $180 - 2\phi$. (ϕ = tooth contact pressure angle). Further shifting of the idler outward will begin to reduce the load slowly.

Conversely, shifting the idler to the other side, Fig. 3, will reduce bearing and housing loads immediately. Hence, it is important to select the optimum side for placing the idler when a choice is available. Smaller bearings, lighter housings and better idler operation will result. For this side, the total bearing load is

$$L = 2T \sin\left(\frac{\beta}{2} - \phi\right) \sec\phi$$

These effects are shown for two different pressure angles in Fig. 4. The 60-deg example on Fig. 4 shows how significant the choice of sides can be in terms of idler bearing load.

Actually, bearing and housing loads could be made to disappear by moving the idler outward until $\beta = 2\phi$, Fig. 5. Theoretically, such positioning could use an idler without any bearing or support, if any designer cared to try it.

In the favorable offset position of Fig. 3, gear forces on the idler push it deeper into mesh with the other two gears. All looseness and deflection that occur in the bearings and housing will reduce

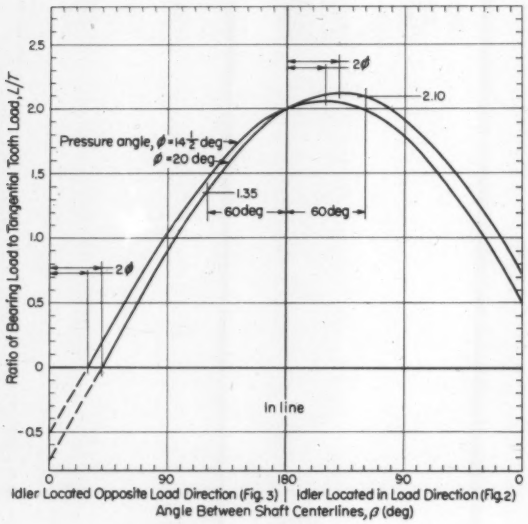


Fig. 4—Effect of idler location upon idler bearing and support load.

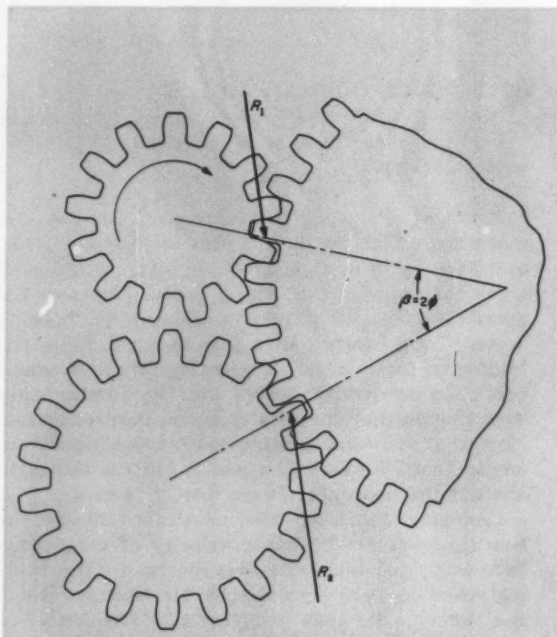


Fig. 5—Configuration for balancing of tooth loads, with no load on idler bearing.

backlash. In such designs, the initial backlash should be kept high, and the centerline distance tolerances on the plus side. This favorable idler position loses its advantage if the direction of rotation reverses or, more exactly, if the direction of loading reverses. It is only possible to favor that side where the loads are larger or more frequent.

Stresses: In an ordinary gear, the large tensile stress at the critical fillet at the base of the tooth occurs once per revolution, Fig. 6*a*. This stressing is a sudden peak lasting only a fraction of each cycle, and does not follow the sinusoidal stressing of the usual fatigue testing machine. However, the rest periods do not change the allowable stresses appreciably from testing machine results. Also, there are kinetic effects for which specific formulas have been developed (Buckingham).

In an idler gear, there are twice as many stressings per revolution—once for each contact. However, these stressings are on opposite sides of the tooth. Hence, any one tooth fillet has alternate tensile and compressive stresses, Fig. 6*b*. Strict application of the Goodman repeated-stress diagram should call for half as large an allowable stress. This large reduction in allowable stresses does not occur because (1) the compressive stresses are less destructive, and (2) one of the mating gears is usually larger, reducing the bending and Hertz stress at this point. Experience indicates that an idler gear should have 10 to 20 per cent lower allowable bending stress to give the same life with the same materials. Allowable Hertz pressures need not be changed at all because they occur on opposite sides of the gear tooth.

The planet gear in a simple planetary system is a true idler in that no torque is transmitted to the shaft. The position cannot be changed as shown in the first figures (except where there is a reversing idler) but the stress-frequency problem is like that of the usual idler. Formulas for the frequency of stressings on any one tooth fillet for the simple planetary system are given in Table 1.

Fig. 7 illustrates relative frequency, size and direction of stresses for parts of a simple planetary gear of 8/1 ratio with three planets.

Single Bearing Mountings: An idler gear requires no torque connection with the shaft. It can be mounted on a nonrotating shaft, with bearings in-

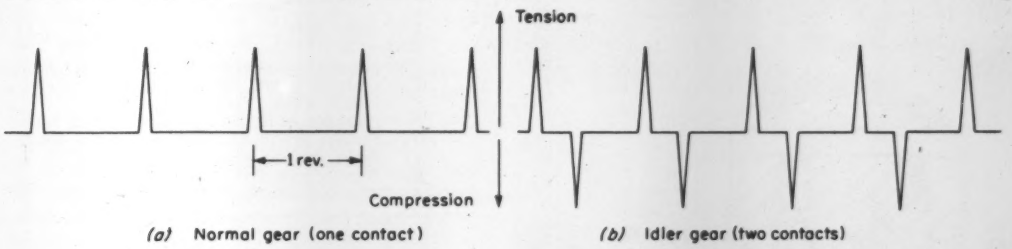


Fig. 6—Above—Stress per revolution at any one tooth fillet.

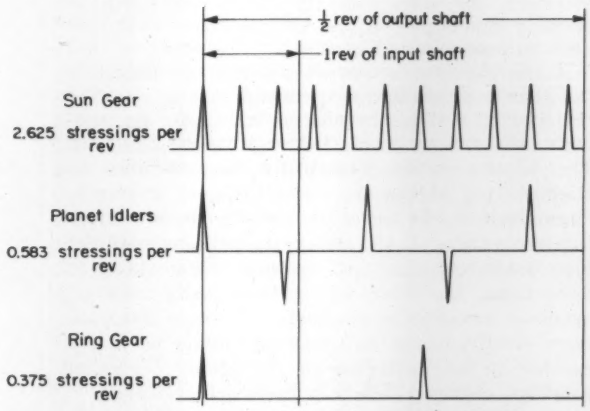


Fig. 7—Stress frequency at the fillet of any one tooth in a simple planetary gear of 8/1 ratio.

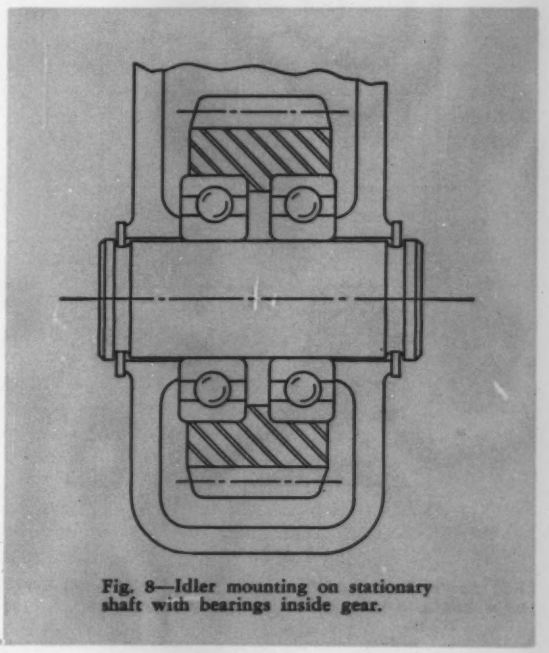


Fig. 8—Idler mounting on stationary shaft with bearings inside gear.

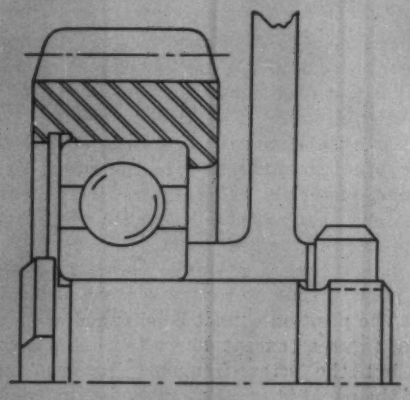


Fig. 9—Idler mounted on a single bearing, which must be on centerline of gear.

Fig. 10—Idlers on integral roller bearings.

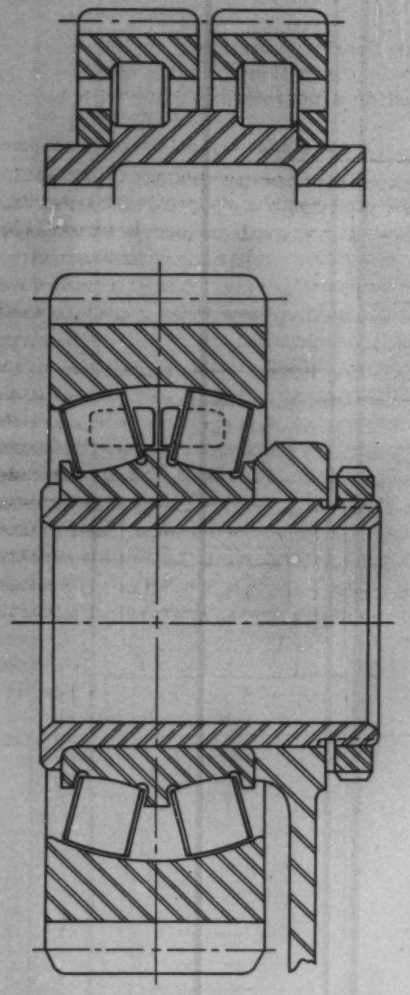


Fig. 11—Heavily loaded aircraft planet idler, mounted on a single, integral, self-aligning roller bearing.

side the gear, and outer races rotating, Fig. 8. This arrangement saves weight, simplifies the housing and provides better alignment. On the other hand, the bearings have higher equivalent speeds because of outer-race rotation. The bearing catalogs usually call for a 40 per cent speed increase in the selection of ratings, but more is needed to allow for the load being concentrated on about one-third of the inner-ring circumference. More exactly, the outer-race rotation gives only about 40 per cent more stressings on the most critical point on the inner race, but in addition, these stressings are each at the maximum value, rather than varying from

Table 1—Stress Frequency in Simple Planetary Systems

Sun Gear

$$Q = fn\left(1 - \frac{1}{e}\right) = fN(e-1) = \frac{fNR}{S}$$

Planet Pinion

$$Q = \frac{2nR}{Pe} = \frac{2NR}{P}$$

Ring Gear

$$Q = \frac{fn}{e} = fN$$

Nomenclature

e = Gear ratio
$= n/N$
f = Number of planet idlers
N = Output speed, rpm
n = Input speed, rpm
P = Number of teeth in planet gear
Q = Stress frequency for any one tooth fillet, cycled per minute
R = Number of teeth in ring gear
S = Number of teeth in sun gear

maximum to zero as in the case of inner-race rotation. This condition requires an additional 25 per cent capacity. This extra capacity can be reduced if the inner race creeps regularly, or if it can be rotated at regular intervals as at overhauls. Furthermore, the extra capacity requirements will be of little importance, if the idler is offset to reduce loads as described in Fig. 3.

If the idler loads can be reduced enough, or if the idler is large, the two bearings of Fig. 8 can be replaced by a single bearing as in Fig. 9. Surprisingly, the gears operate better when so mounted. The bearing offers practically no resistance to slight tilting of the gear, and the gear is free to align itself at the tooth for perfect contact across the whole face. If the two gears meshing with the idler are out of alignment, because of machining or deflections, the idler will automatically take an optimum compromise position. To obtain this optimum condition, the ball bearing should be placed exactly on the centerline of the gear. For roller bearings, crowned rollers or races are preferred.

This automatic alignment has special value for the planetary idler. Normally, the planet carrier deflects enough to affect the gear tooth alignment, and it is made especially heavy to reduce these de-

flections. A single bearing idler mounting makes this rigidity unnecessary. The carrier can be designed for strength alone and can be very much lighter as in Fig. 11. Here the usual outboard wall of the carrier has been omitted. Also, the lighter and more flexible carrier provides more spring action to help the load distribution among the planets.

Resulting weight reduction is especially valuable for aircraft gearing. Where space inside the idler is limited, integral designs like that of Fig. 10 are used. This particular design is manufactured by one of the bearing companies.

Fig. 11 shows an advanced type of this single-bearing idler mounting as used on heavy-duty aircraft planetaries in turboprops or helicopters. The integral type self-aligning roller bearing gives the idler complete freedom to tilt to any degree, and the planet carrier is extremely light in weight.

Wall thickness under the gear teeth in Figs. 8 to 11 needs to be larger than the commonly accepted minimum limit of one tooth depth. The two loads on an idler gear at approximately 180 deg and in the same direction give unexpectedly large ring deflections that affect bearing action and increase gear bending stresses. One 5-in. planet showed 0.010-in. collapsing and reduction in diameter, causing extra bearing loads because the wall was too thin. An approximate rule is that wall thickness should not be less than 1.75 times tooth depth.

They Say . . .

"Development of suitable (engineering and technical) personnel is a serious problem because the supply of suitable personnel is very limited. Therefore, it is necessary to train engineering and shop personnel and, in doing this, personnel must not be bogged down with tradition or prejudice. As a yardstick, the management or manager can usually look for improper procedure if these men do not bring up ideas or methods that curl the hair of old timers. It is either possible that the men do not have the proper ability or that their efforts are being thwarted by prejudice or tradition. If the situation is not corrected there is eventual failure in achieving success in . . . design."—JOHN MIKULAK, *assistant to vice-president — manufacturing, Worthington Corp., Harrison, N. Y.*

"The mechanical design of electronic equipment is frequently considered to be of secondary importance as compared with the electronic functions. However, military experience has shown that inadequacies of mechanical features have contributed as much, if not more, to equipment faults than electronic-design deficiencies. The NEL Reliability Design Handbook shows that of 28 categories of equipment faults commonly found in electronic-equipment failures, 16 are mechanical. Considering frequency of occurrence, the total number of mechanical faults approximately equals the number of electronic faults."—L. JACOBS, *Radio Corp. of America, Moorestown, N. J.*

"The electronization of 'mental' operations (by electronic computers) will no doubt result in many dislocations, and significant readjustments will have to be made in the thinking processes of many people. However, by and large, only great benefits will come as a result of this development.

"We can dispel our apprehensions concerning the electronic 'eggheads' if we remember that, just as in the case of the electric steam shovel, the high-speed electronic calculator is only a tool. With its aid we can expect to break through many frontiers of knowledge which have hitherto been impenetrable."—DR. H. POLACHEK, *Applied Mathematics Laboratory, David Taylor Model Basin, Bethesda, Md.*

"In the last 50 years in the United States of America the per-man per-hour production of a single production worker, whether he is in agriculture or industry, has increased at the rate of approximately 3.3 per cent per year. Statistically that means that in the past 50 years the per-man per-hour production of a man engaged in productive activity in American industry has increased roughly 373 per cent."—DR. O. MEREDITH WILSON, *president, University of Oregon.*

"The design must be based on a knowledge and experience of storage, shipping, installation, field operating, and maintenance conditions; a knowledge of mature electronic and mechanical design considerations; and manufacturing practices. It must be supplemented by the experience, the judgment, and the competence of the development and design engineers, the supporting services, and the manufacturing organization.

"This will result in simple equipment to perform the complex tasks required, equipment which can be economically produced by the factory and lower overall costs due to minimizing the duplication of effort, the factory troubles, scrap loss, and field-maintenance cost. There is no substitute for competence and experience."—L. M. CLEMENT, *AVCO Corp., Crosley Div., Washington, D. C.*

Mechanics of Vehicles—12

By JAROSLAV J. TABOREK*
Towmotor Corp.
Cleveland

AVAILABLE friction at the tire-ground contact point sets a basic limitation to the stopping capacity of a vehicle braking system. Assuming that such frictional contact is adequate, a further braking limit is set by the ability of brake-system mechanical components to absorb or dissipate heat generated during vehicle deceleration. Continuing the study of the braking vehicle, this article examines fundamental limits to brake performance and presents design criteria that lead to optimum system performance.

Braking-Force Limits: Maximum transferable braking force, since it is dependent upon frictional ground reaction, is a function of dynamic axle weight and the available coefficient of road adhesion. The mathematical relationship is

$$B_{max} = W_b \mu \qquad (217)$$

where W_b is the dynamic weight on the braking axle. When this equation is substituted into equations for dynamic axle weights (Equations 194 and 195, Part 11), braking-force limits for front, rear, and four-wheel systems can be derived as follows:

FRONT-WHEEL BRAKES:

$$B_{f\,max} = W_{bf}\,\mu \qquad (218)$$

$$W_{bf} = \frac{L_r W}{L} + \frac{H}{L}\left(W_{bf}\,\mu + fW \right) \qquad (219)$$

$$W_{bf} = \frac{W(L_r + fH)}{L - \mu H} \qquad (220)$$

$$B_{f\,max} = \frac{\mu W(L_r + fH)}{L - \mu H} \qquad (221)$$

*Now Research and Development Engineer, Phillips Petroleum Co., Bartlesville, Okla.

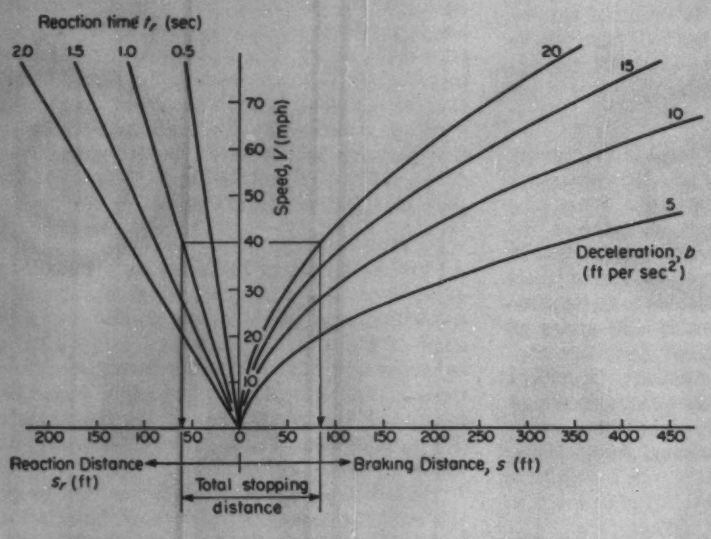


Fig. 64—Total stopping distance as a function of vehicle speed and driver reaction time. In example shown, distance traveled before brake application during reaction time of 1 sec is 59 ft; distance traveled during maximum-deceleration braking is 85 ft. Total stopping distance is therefore 144 ft.

Example: Determine the maximum grade on which an 8000 lb vehicle can be braked (at brake equilibrium temperature) without assistance from engine. Intersection of the 50-mph ordinate with the N_b curve is found at the 40,000 power-input line. Therefore, assuming $f = 0.02$,

$$G = \frac{40{,}000}{W} + 100f = \frac{40{,}000}{8000} + 2$$

$$= 7 \text{ per cent}$$

With the engine braking in high gear, intersection of the 50-mph ordinate and the power-input line is at 60,000. This value corresponds to a 9.5 per cent grade. Similarly, in second gear, the maximum grade is 15 per cent.

Speed of descent for a free-rolling vehicle ($N_b = 0$ and $N_{ad} = 0$) is found at the intersections of the power-input lines and the N_e curve. For example, on a grade of 4.5 per cent (20,000 line), the speed of free descent is 96 mph.

Braking Performance Limits

transferable braking forces
tractor-trailer braking
heat dissipation
heat storage

REAR-WHEEL BRAKES:

$$B_{r\,max} = W_{br}\,\mu \tag{222}$$

$$W_{br} = \frac{L_f\,W}{L} - \frac{H}{L}\left(W_{br}\,\mu + fW\right) \tag{223}$$

$$W_{br} = \frac{W(L_f - fH)}{L + \mu H} \tag{224}$$

$$B_{r\,max} = \frac{\mu W(L_f - fH)}{L + \mu H} \tag{225}$$

FOUR-WHEEL BRAKES: Since the effective axle weight equals the full vehicle weight, then

$$B_{4\,max} = \mu W \tag{226}$$

Substituting this expression into Equations 194 and 195:

$$W_{4f} = \frac{W}{L}\left[L_r + H\left(\mu + f\right)\right] \tag{227}$$

$$W_{4r} = \frac{W}{L}\left[L_f - H\left(\mu + f\right)\right] \tag{228}$$

The condition of maximum brake performance as expressed by Equation 228 is realized only when distribution of braking forces to the axles is in proportion to their respective dynamic weights. That is,

$$\frac{B_{4f}}{B_{4r}} = \frac{W_{4f}}{W_{4r}} = \frac{L_r + H(\mu + f)}{L_f - H(\mu + f)} \tag{229}$$

In a subsequent development (Equation 236), a simplified expression for maximum deceleration is derived as

$$b = g(\mu + f)$$

Combining this expression with Equation 229,

$$\frac{B_{4f}}{B_{4r}} = \frac{L_r g + bH}{L_f g - bH} \tag{230}$$

Both equations for braking-force distribution (Equations 229 and 230) are functions of the widely changing variables of road adhesion μ and deceleration b. As a consequence, the braking-force distribution ratio would ideally have to be adjust-

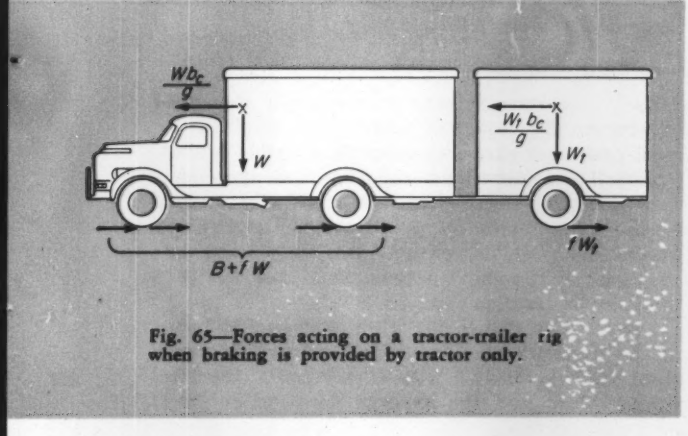


Fig. 65—Forces acting on a tractor-trailer rig when braking is provided by tractor only.

Nomenclature

A	= Projected vehicle area in drive direction, sq ft
B	= Brake force at tire-ground contact point, lb
B_{4f}, B_{4r}	= Brake forces on front and rear axles, four-wheel brakes, lb
c_a	= Air resistance coefficient
E	= Kinetic energy, ft-lb
E_t	= Energy in thermal units, Btu
G	= Grade or gradability, per cent
H	= Height of vehicle cg from ground, in.
I	= Polar moment of inertia, lb-sec²-ft
L	= Wheelbase, in.
L_f, L_r	= Distance between vehicle cg and front and rear axles, in.
M_e	= Engine torque, lb-ft
N_a	= Power required to overcome air resistance, hp
N_{ad}	= Braking power supplied by additional sources, hp
N_b	= Energy conversion rate in brake, hp or Btu per hr
N_g	= Power required to overcome grade resistance, hp
N_r	= Power required to overcome rolling resistance, hp
Q_b	= Thermal capacity of brake drum, Btu
R_a	= Air resistance, lb
R_g	= Grade resistance, lb
R_i	= Total inertia resistance, lb
R_r	= Rolling resistance, lb
R_{rf}, R_{rr}	= Rolling resistances on front and rear-axle wheels, lb
ΣR	= Summation of resistance forces, lb

Example 5—Braking-Force Distribution

Problem: Determine distribution on a vehicle with design configuration $L_f = L_r = 0.5L$ and $H = 0.35L$. With an average value $\mu = 0.35$, Equation 229 gives

$$\frac{B_{4f}}{B_{4r}} = \frac{0.5 + 0.35(0.35 + 0.02)}{0.5 - 0.35(0.35 + 0.02)} = \frac{63}{37}$$

In other words, for the assumed weight distribution, braking-force distribution is 63 per cent to the front wheels and 37 per cent to the rear wheels.

able to assure optimum braking effect. This condition, however, has not been realized in practice, and in the design of brake systems an average value of road adhesion $\mu = 0.35$ is usually assumed as compromise. This corresponds to deceleration b = 11.5 ft per sec.² As deceleration increases, or as values of road adhesion coefficient increase, the braking effort exerted by the front wheels increases. Example 5 illustrates a typical calculation of brake-force distribution.

Limits of Deceleration: Substituting Equation 217, the braking force limit expression, into the equation of decelerated motion (Equation 202, Part 11, then

$$B_{max} = \mu W_b = \gamma_b mb - R_r \pm R_g - R_a \qquad (231)$$

Deceleration b then becomes b_{max}, where

$$b_{max} = \frac{g}{\gamma_b}\left[\frac{W_b\,\mu}{W} + f - \sin(\pm\theta) + \frac{R_a}{W}\right] \qquad (232)$$

When the dynamic axle weight term W_b is replaced by the values given in Equations 220, 224, and 226 (front, rear, and four-wheel brakes), the maximum decelerations obtainable under given friction conditions are as follows:

FRONT WHEEL BRAKES:

$$b_{max} = \frac{g}{\gamma_b}\left[\frac{(L_r + fH)\mu}{L - \mu H} + f - \sin(\pm\theta) + \frac{R_a}{W}\right] \qquad (233)$$

REAR-WHEEL BRAKES:

$$b_{max} = \frac{g}{\gamma_b}\left[\frac{(L_f - fH)\mu}{L + \mu H} + f - \sin(\pm\theta) + \frac{R_a}{W}\right] \qquad (234)$$

FOUR-WHEEL BRAKES:

$$b_{max} = \frac{g}{\gamma_b}\left[\mu + f - \sin(\pm\theta) + \frac{R_a}{W}\right] \qquad (235)$$

The above equations include the effects of rolling, grade, and air resistances, and show that deceleration is independent of vehicle weight only when air resistance can be neglected, that is, at low speeds. The loaded vehicle, therefore, is at a disadvantage when compared to the same vehicle in the empty condition. This is because the retarding effect of air resistance (per unit weight) is smaller and the resulting deceleration is therefore lower.

When air resistance (which can be considered as a safety factor) is neglected, Equation 235 can be simplified to the form

$$b = \frac{g}{\gamma_b}\left(\mu + f\right) \approx g\left(\mu + f\right) \qquad (236)$$

The road-adhesion coefficient value $\mu = 0.6$ is usually assumed for dry concrete, leaving a sufficient margin for directional side forces. Maximum deceleration is then

$$b_{max} = 32.2(0.6 - 0.02) = 20 \text{ ft per sec}^2 \qquad (237)$$

Such decelerations have been actually measured experimentally and can usually be attained by most passenger cars with properly adjusted brakes. Practical considerations, such as passenger comfort and the shifting of loads, usually impose much lower limits on deceleration. Deceleration values over 10 ft per sec² are considered unpleasant; values higher than 15 ft per sec² are used only in emergencies.

Deceleration values are often expressed in terms of the gravitational constant g. Maximum deceleration on dry concrete (20 ft per sec²) then becomes $0.64g$, and the average deceleration 10 ft

Example 6—Parking-Brake Calculations

Problem: Determine the maximum grade on which a rear-axle parking brake will hold a vehicle with dimensions $L_f = L_r = 0.5L$ and $H = 0.35L$. Assume the surface is slippery with friction coefficient $\mu = 0.2$.

Equation 246 gives the maximum grade G_{max} as

$$G_{max} = \frac{100[0.2(0.5) + 0.02]}{1 + 0.35(0.2)} = 11 \text{ per cent}$$

for the downhill-pointing vehicle, and

$$G_{max} = \frac{100[0.2(0.5) + 0.02]}{1 - 0.35(0.2)} = 13 \text{ per cent}$$

for the uphill-pointing vehicle.

Problem: Determine the minimum coefficient of friction required to hold the vehicle stationary on a slope of 30 per cent.

From Equation 247, required values are

$$\mu_{min} = \frac{30 - 2}{100(0.5) - 0.35(30)} = 0.71$$

for the downhill-pointing vehicle, and

$$\mu_{min} = \frac{30 - 2}{100(0.5) + 0.35(30)} = 0.46$$

for the uphill-pointing vehicle.

per sec² equals $0.32g$.

An average automobile collision, which is essentially an extremely abrupt stop, is about 1 to $4g$ in terms of deceleration. Limits of human survival seem to be somewhere around $20g$ and, as an example, a head-on collision at 40 mph produces a deceleration of about $16g$ or 510 ft per sec.²

As stated in a foregoing section, deceleration limits on dry concrete are seldom reached in everyday driving. The superiority of the four-wheel brake system is, therefore, more apparent when the vehicle is driven on slippery surfaces of low μ values, since the braking work is distributed over more application points.

Actual Stopping Distance: In an emergency stop, a certain time elapses before the driver can take his foot from the accelerator and depress the brake pedal. Called the reaction time, the time interval has been measured experimentally as falling between 0.5 and 2.0 sec. Actual stopping distance, $S = s_r + s$, can be calculated from the relationship

$$S = vt_r + \frac{v^2}{2b}$$

In this equation, the first term on the right side is the distance traveled during the reaction time before the brake is applied. The second term, which results from combination of Equation 236 and Equation 206 (Part 11), is the braking distance. The importance of reaction time in braking calculations is graphically illustrated in Fig. 64.

Example 7—Braking-Power Calculation

Problem: Determine the energy that must be absorbed by the brake system in a vehicle which is descending a slope of 10 per cent at a steady speed of 50 mph. Vehicle weight is 20,000 lb.

Rate at which potential energy is converted in the descending vehicle is given by the expression

$$N_g = \frac{WGV}{37{,}500} = \frac{20{,}000(10)(50)}{37{,}500} = 266 \text{ hp}$$

Assuming $f = 0.02$, the power consumed by rolling resistance is

$$N_r = \frac{WfV}{375} = \frac{20{,}000(0.02)(50)}{375} = 53 \text{ hp}$$

For an assumed $c_a = 0.8$ and $A = 70$ sq ft, power consumed by air resistance is

$$N_a = \frac{0.26 c_a A V^3}{37{,}500} = \frac{0.8(70)(50)^3}{144{,}000} = 47 \text{ hp}$$

Power that must be absorbed by the brake system is therefore

$$N_b + N_{ad} = N_g - (N_r + N_a)$$
$$= 266 - (53 + 47) = 166 \text{ hp}$$

Despite the relatively high speed of 50 mph, air resistance counteracts only about 18 per cent of the total energy converted on the grade.

Special Applications: Solution of any particular braking-performance problem can be easily calculated from combination of the equation of decelerated motion (Equation 202), the equations for static and dynamic axle weights (Equations 194 and 195), and the equation of maximum transferable braking force. The procedure is demonstrated for two special applications in the following sections.

DECELERATION OF TRACTOR-TRAILER COMBINATION: If, on a tractor-trailer combination, brakes are provided only on the tractor, braking power of the tractor must obviously decelerate both vehicles. From Fig. 65, the force balance is

$$B = \frac{b_c}{g}\left(W + W_t\right) - f\left(W + W_t\right) \qquad (238)$$

where subscript t applies to the trailer only, and c refers to the combination.

Limit of braking force produced by the tractor is given by the relation

$$B_{max} = W\mu \qquad (239)$$

When Equations 238 and 239 are equated, maximum deceleration of the combination becomes

$$b_{c\,max} = g\left[\frac{W\mu}{W + W_t} + f\right] \qquad (240)$$

Often a certain allowable minimum deceleration of the tractor-trailer combination is required for safety reasons. In such case, the maximum permissible weight of the trailer can then be calculated as

$$W_{t\,max} = W\left[\frac{g(\mu + f) - b_c}{b_c - gf}\right] \qquad (241)$$

After substitution of Equation 236 for maximum deceleration of the tractor alone, and neglecting rolling resistance which, in this case, is of little importance, Equation 241 becomes

$$W_{t\,max} = W\left[\frac{b}{b_c} - 1\right] \qquad (242)$$

As an example of such a calculation, assume that the weight of the trailer must be determined if the minimum required deceleration on dry concrete is 15 ft per sec². From Equation 237, the deceleration of the tractor alone is $b = 20$ ft per sec². From Equation 242,

$$\frac{W_{t\,max}}{W} = \frac{20}{15} - 1 = 0.33$$

This shows that the trailer can have a maximum weight equal to 33 per cent of that of the tractor.

PARKING BRAKE HOLDING POWER: Parking-brake action represents a special form of the braking problem since it concerns the stationary vehicle.

The function of a parking brake is to retain the vehicle on a grade at least equal to vehicle gradability, usually by restraining the driving axle. The force equation in this case is

$$W \sin \theta - fW \cos \theta = B \qquad (243)$$

Here, plus and minus signs of the different terms do not change in relation to each other, if the slope either is downhill or uphill.

Braking force is limited by available ground friction which, in turn, is a function of weight acting on the braking axle. For a rear-axle parking brake, the equation for stationary axle weights applies (Equation 91, Part 7):

$$W_r = \frac{W}{L}\left[L_f \cos \theta - H \sin \left(\pm \theta \right) \right] \qquad (244)$$

where $+\theta$ applies to the vehicle pointing downhill. This represents the worst case possible, since weight transfer is away from the rear or braking axle. Combining Equations 243 and 244 with the applicable limit equation

$$B_{max} = W_r \mu$$

resulting expression is

$$W \sin \theta - fW \cos \theta = \frac{\mu W}{L}\left[L_f \cos \theta \pm H \sin \theta \right] \qquad (245)$$

After rearrangement and substitution of $G = 100 \tan \theta$, then

$$G_{max} = 100 \left[\frac{\frac{\mu L_f}{L} + f}{1 \pm \frac{\mu H}{L}} \right] \qquad (246)$$

where G in per cent and the plus sign in the denominator refers to a downhill pointing vehicle.

Minimum coefficient of friction required to hold the vehicle on a grade of G per cent is obtained by rewriting Equation 246 as

$$\mu_{min} = \frac{G - 100f}{\frac{100 L_f}{L} \pm \frac{HG}{L}} \qquad (247)$$

It is interesting to note that the maximum grade on which the parking brake is able to hold is independent of vehicle weight and is a function of weight distribution and friction coefficient only. Example 6 illustrates typical parking-brake holding-power calculations.

Braking-Heat Effects: In foregoing sections, elementary equations of motion and the relationships between forces acting on a vehicle in decelerated motion were established. These equations, however, did not consider braking-performance limitations imposed by the energy conversion rate in the brake and the accompanying temperature rise in both drum and lining.

Basically, a brake performs an irreversible conversion of potential or kinetic energy into heat. This conversion is a frictional process, which can take place in the brake drum or, undesirably, at the tire-ground contact area when the braked wheel skids. In following sections, braking calculations are carried out from the viewpoint of energy conversion, and basic equations and design criteria are established.

Heat created in the brake raises the temperature of the friction surfaces, which, in turn, sets the limiting factor on brake performance. This is because the friction coefficient value of the brake lining decreases rapidly with higher temperatures, and braking torque falls off correspondingly. Furthermore, resistance of the linings against abrasion also declines at higher temperatures, affecting the service life of the brakes. Design of a brake system must be carried out so that lining operating temperatures, even under the most severe anticipated performance requirements, will stay below limits for which frictional and abrasive properties are acceptable.

From an energy conversion standpoint, braking calculations described here are based on two different operational conditions:

1. Moderate brake application of long duration, for example, on a vehicle descending a long downhill grade. For such brake operation at constant temperature, equilibrium must be established be-

Example 8—Braking-Heat Calculation

Problem: Determine average energy-conversion rate and temperature rise in the brakes of an aircraft decelerating at a 10 ft per sec^2 rate from an initial speed of 100 mph. Gross weight of the aircraft is 80,000 lb; brake weight is 400 lb. Effects of air resistance and kinetic energy of rotating parts are neglected.

Equation 255 gives the average energy-conversion rate as

$$N_b = \frac{WV_m}{375}\left[\frac{b}{g} - f \right]$$

$$= \frac{80{,}000(100)}{375(2)}\left[\frac{10}{32} - 0.02 \right]$$

$$= 3050 \text{ hp}$$

Total work performed in stopping the aircraft equals the kinetic energy converted, or from Equation 257

$$E = \frac{80{,}000(100)^2}{30(778)}$$

$$= 34{,}500 \text{ Btu}$$

Assuming specific heat of the brake-drum material is $c = 0.11$, temperature rise in the drums is given by Equation 260 as

$$\Delta t = \frac{34{,}500}{0.11(400)} = 780\ F$$

tween the frictional heat generated in the brake and the heat dissipated by the brake to the outside air.

2. Severe brake application of short duration, for example, in an emergency stop. In this case the total kinetic energy converted during deceleration must be absorbed by the heat storage capacity of the brake. This is because heat dissipation during the short braking period is negligible.

The following sections give further details on these brake-application conditions.

Braking-Heat Dissipation: The heat-dissipation rate of the brake is the performance determining factor where braking is intermittent but frequent. This is the case in bus service, for example, or during braking of extended duration.

Basis for the heat-dissipation calculation is the energy-conversion rate and heat-flow balance at the brake drum. Temperature of the brakes of a vehicle descending a grade at constant speed increases until it reaches a constant value where equilibrium between energy conversion and heat dissipation has been reached. Obviously, as heat conduction from the lining contact area improves, energy-handling capabilities of the brake also increase.

Heat exchange in the brake is brought about by the usual processes:

1. *Conduction* through the shoe and brake drum to the adjoining parts in direct contact.

2. *Radiation,* which takes place between all brake parts and surrounding surfaces. Since radiation is a function of absolute temperature, it is usually neglected because of the relatively low brake operating temperatures.

3. *Convection,* especially from the outside surface of the drum, to the ambient air. This accounts for the largest part of the heat exchange in the brake. The amount of heat convected is a function of the size and quality of the contact surface and the velocity and turbulence of the air flow. Diametral ribs are usually provided on the drums of high-capacity brakes, and an air stream is diverted to them from openings in the tire rims, or by proper shaping of surrounding sheetmetal body parts. When special cooling provisions are not made, brakes hidden deep in the tire rim often show poor performance because of inadequate convection cooling.

Because of the many variables influencing heat flow from the brake, no systematic mathematical analysis has yet been made. Instead, the problem is handled by measurements in wind tunnels, or by towing the vehicle to obtain characteristic heat-dissipation curves. These curves usually form a family, Fig. 66, each curve representing a certain constant brake temperature plotted against vehicle speed, which is the important heat-convection influencing factor. On new designs, estimates are made on a basis of similarity to comparable existing types.

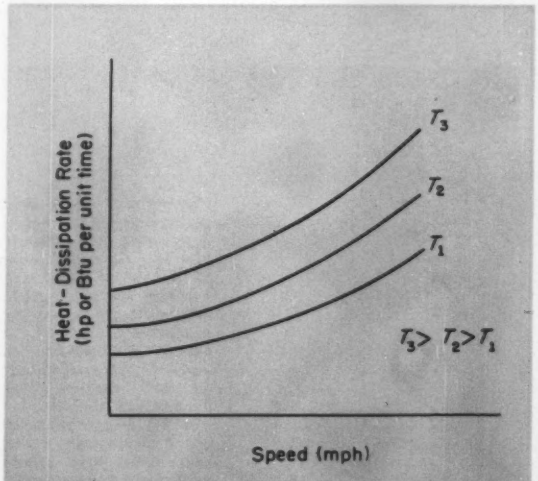


Fig. 66—Heat dissipation or energy-conversion rate in a brake as a function of vehicle speed. Rate of heat dissipation from the brake is proportional to temperature and to vehicle speed. Higher speeds improve the convective transfer of heat from brake components. Energy-conversion rate in the braking system of a vehicle descending a grade must remain below the heat-dissipation capacity of the system if equilibrium brake temperatures are to be established.

Energy-Conversion Equations: The equation of forces acting on a vehicle descending a downhill slope with constant speed is derived from Equation 202 (Part 11) setting $b = 0$,

$$B + B_{ad} = R_g - R_r - R_a \qquad (248)$$

In other words, the sum of B, the actual braking force, and B_{ad}, the braking force derived from the engine or other additional sources, equals the algebraic sum of grade resistance and rolling and air resistances.

Expressed in power units, Equation 248 becomes

$$N_b + N_{ad} = \frac{V}{375}\left(R_g - R_r - R_a\right) \qquad (249)$$

After substituting the terms for the resistance forces,

$$N_b + N_{ad} = \frac{VWG}{37{,}500} - \frac{VWf}{375} - \left[\frac{0.26\, c_a A}{37{,}500}\right] V^3 \qquad (250)$$

where N_b is the energy conversion rate in the brake (hp) and N_{ad} is braking power supplied by additional sources.

A general solution for this equation, which would be applicable to all vehicles, cannot be found, since the air-resistance factors c_a and A are particular to each vehicle. The effect of vehicle weight can, however, be eliminated by considering the product $W(G - 100f)$ as the variable. In other words, the same energy conversion rate is

reached when a vehicle of 2000 lb descends a grade of 5 per cent as for the case of a 10,000 lb vehicle on a 1 per cent grade. This substitution permits use of the same diagram for calculation of brake performance for all vehicles having the same product c_aA, regardless of weight. Rearranged, Equation 249 becomes

$$N_b + N_{ad} = \frac{VW(G - 100f)}{37{,}500} - \frac{c_aAV^3}{1440} \qquad (251)$$

The first term on the right side of this equation represents the total net power input, while the second term is the power consumed by air resistance. To maintain temperatures within permissible limits, the energy conversion N_b in the brake must be kept below the thermal capacity of the brake, this capacity being established by its heat dissipation curve (Fig. 66). Any braking-power requirements beyond such equilibrium must be supplied by additional braking sources, represented by N_{ad}.

Equation 251 is solved by graphical methods to give, for any value of W and G, the following performance results: 1. Speed of descent of a free-rolling vehicle. 2. Maximum permissible speed of descent for a particular brake. 3. Additional braking power required and the gear ratio to be used to achieve the desired braking performance. The principles and techniques for use of the diagram are shown in Fig. 67.

One possible simplification is to consider air resistance as a safety factor and omit it from the calculations. This is permissible with little error when the anticipated maximum speed of descent is under 50 mph, which is usually the case in most automotive applications. The simplified form of Equation 251 is then

$$N_b + N_{ad} = \frac{VW(G - 100f)}{37{,}500} \qquad (252)$$

This equation can also be solved again by the graphical method mentioned earlier. The basic diagram has general validity for all vehicles, each particular case being solved by superimposing on the diagram the braking power of the engine and the heat dissipation curve of the brake under consideration. Example 7 illustrates the technique.

Heat-Storage Capacity: If quick deceleration of the vehicle is the main objective of brake application, duration of the process is short, and heat dissipation from the brake is negligible. The functional limitation of the system is then the heat-storage capacity of the drum.

The drum must absorb a heat quantity equivalent to the maximum anticipated kinetic energy of the vehicle without reaching a critical temperature on the brake lining.

As in calculations in Part 11, the engine is considered to be disengaged, and the force equation becomes

$$B = \gamma_b mb - R_r - R_a + R_g \qquad (253)$$

where the positive sign on the grade resistance term R_g applies to a downhill grade.

The instantaneous energy conversion rate in the brake N_b (hp), corresponding to deceleration from speed V (mph), can be calculated from Equation 253 as

$$N_b = \frac{V}{375}\left[\gamma_b mb + R_g - R_r - R_a\right] \qquad (254)$$

Speed decreases during deceleration and so does

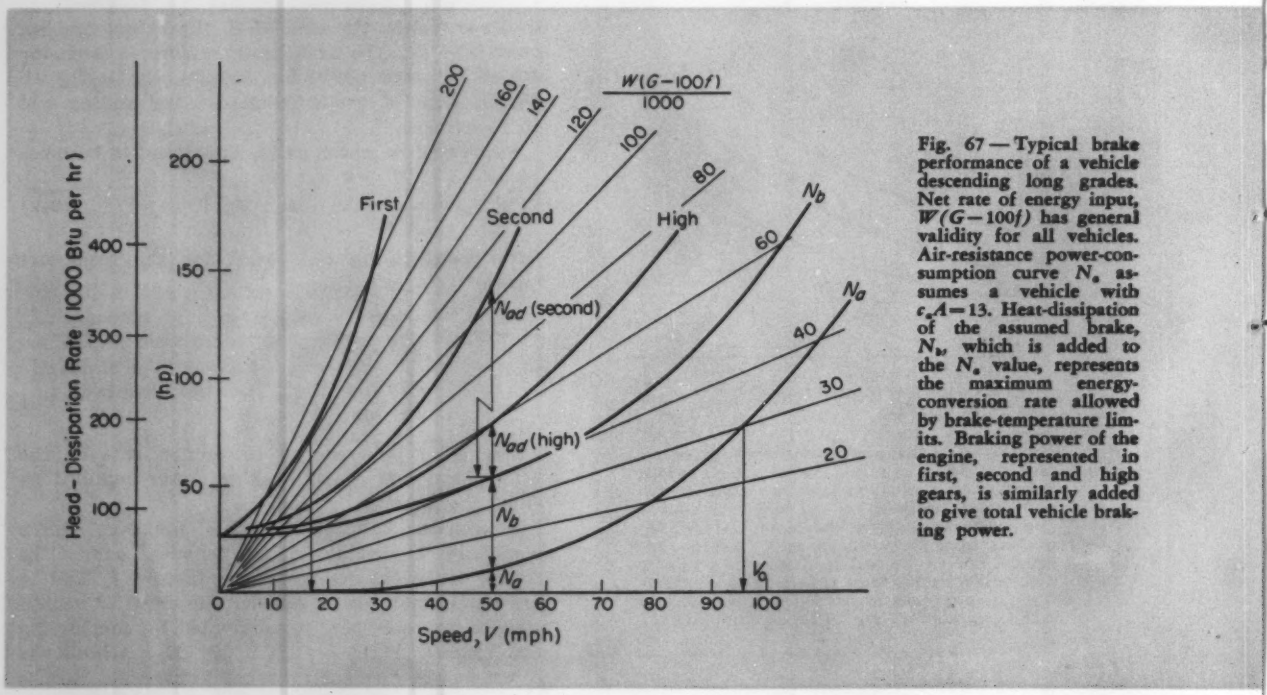


Fig. 67 — Typical brake performance of a vehicle descending long grades. Net rate of energy input, $W(G-100f)$ has general validity for all vehicles. Air-resistance power-consumption curve N_a assumes a vehicle with $c_aA = 13$. Heat-dissipation of the assumed brake, N_b, which is added to the N_a value, represents the maximum energy-conversion rate allowed by brake-temperature limits. Braking power of the engine, represented in first, second and high gears, is similarly added to give total vehicle braking power.

the energy conversion rate. The calculation is therefore made for the mean speed

$$V_m = \frac{V_i + V_f}{2}$$

For a full stop, this becomes

$$V_m = \frac{V_i}{2}$$

Neglecting air resistance, the mean energy-conversion rate in decelerating a vehicle of weight W descending a downgrade slope of G per cent is

$$N_b = \frac{WV_m}{375}\left[\frac{b\gamma_b}{g} + \frac{G}{100} - f\right] \qquad (255)$$

Brake calculations based on sudden braking are based on the total kinetic energy freed when the vehicle slows down from V_i to V_f. Furthermore, the power-consuming effect of rolling and air resistance is usually neglected and the assumption made that total kinetic energy E (ft-lb) is absorbed by the brake, or

$$E = m\left(\frac{v_i^2 - v_f^2}{2}\right) = \frac{W(V_i^2 - V_f^2)}{2g}\left[\frac{5280}{3600}\right]^2$$

$$= \frac{W(V_i^2 - V_f^2)}{30} \qquad (256)$$

Expressed in thermal units, and for a full stop, Equation 256 becomes

$$E_t = \frac{WV_i^2}{30(778)} = \frac{WV_i^2}{23{,}200} \quad \text{(Btu)} \qquad (257)$$

When the amount of heat created in the brake has been established, the temperature rise and the required weight of the brake drum can be calculated. Thermal storage capacity of the brake drum is:

$$Q_b = cW_{dr}\Delta t \qquad (258)$$

where Q_b is the thermal capacity of the brake drum, W_{dr} is the weight of the brake drum, c is the specific heat of the drum material, and Δt is the temperature rise in the drum. Letting $E_t = Q_b$, the required weight W_b of heat-absorbing material can be determined for which converted kinetic energy would raise the temperature only the permissible amount Δt. The expression is

$$W_{dr} = \frac{E_t}{c\Delta t} = \frac{WV_i^2}{23{,}200\, c\Delta t} \qquad (259)$$

Temperature rise Δt, which results from heat input that is equivalent to the kinetic energy converted, is therefore

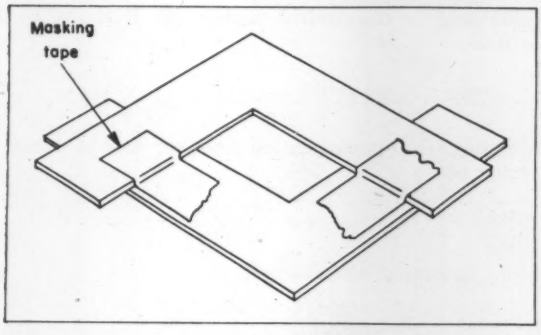
$$\Delta t = \frac{E_t}{cW_{dr}} = \frac{WV_i^2}{23{,}200\, cW_{dr}} \qquad (260)$$

A typical calculation of these effects is illustrated in Example 8.

Tips and Techniques

Stops Hooking Straightedge

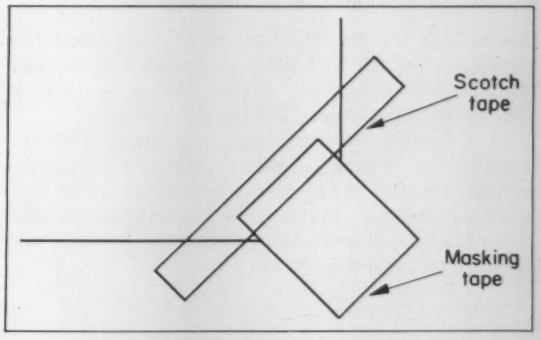
The annoyance of hooking a straightedge, or drafting-machine scales, on the tapes that hold a drawing to the drawing board can be prevented by



use of Scotch tape. After the masking tape is applied to the drawing, a piece of Scotch tape is applied over the masking tape. The thin, smooth Scotch tape will carry straightedges and scales over the masking tape without danger of hooking the straightedge or drafting-machine scale, or tearing the drawing.—BLAISE D'ANKA, *Cleveland.*

Adjustable Square Template

When making block-diagram drawings, the need often arises for different-size squares or blocks. To save drawing each one by layout, an adjustable template can be made. Two pieces of 1/32-in. plastic are cut to the shape of miniature carpenter's

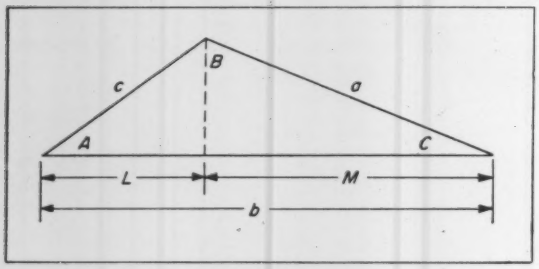


squares—or the squares may be purchased in school-supply stores. Masking tape holds the two squares together to form the proper-size block.—A. V. MALONE, *designer, Associated Missile Products Corp., Pomona, Calif.*

Tips and Techniques

Solving Oblique Triangles

Two simple equations are very useful when calculating co-ordinates of oblique triangles, such as are found in designing gear trains, etc. Both of the equations are based upon having three known sides.



$$L = \frac{b^2 + c^2 - a^2}{2b}$$

$$M = \frac{b^2 + a^2 - c^2}{2b}$$

—Raymond A. Capelli, *Reeves Instrument Corp., Mineola, L. I.*

Accurate Strobe Reading

In performing speed measurements with a stroboscopic tachometer, it is sometimes difficult to determine which multiple or submultiple of the speed is the true speed. If the rotating part is marked with a single spot, the spot will appear stationary at speeds of

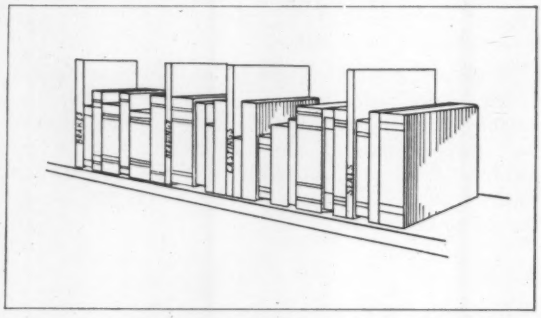
$$\frac{N}{K_1} \ldots\ldots \frac{N}{3}, \frac{N}{2}, N, 2N, 3N, \ldots\ldots K_2N$$

limited only by the persistence of vision and the flashing rate of the tachometer. At speeds less than N, one image will appear, while at greater speeds, multiple images will occur.

To determine the true rotational speed, scan upward in the frequency range. At several places, synchronization of the image will occur. The frequency just before the multiple image appears identifies the true speed.—Arne Benson, *Sanders Associates Inc., Nashua, N. H.*

Literature-Shelf Dividers

Plywood squares are an easy way to divide classified literature and catalogs on a shelf or in a bookcase. First, make a list of the classifications needed. Then have squares cut to a convenient size from ⅜ or ½-in. plywood. Paint one edge with light-colored paint, preferably white. With a speedball pen, letter the name of the classification on the painted surface. If necessary, an eraser can



be used to roughen the paint so that it holds the ink better. A coat of clear lacquer, such as nail polish, will protect the lettering. — Theodore Katsanis, *Seattle, Wash.*

Determining Square Roots

Technical handbooks give the square root only of numbers from 1 to 1000. If it is necessary to get the square root of a number of several digits, an approximation may be employed:

$$\sqrt{a^2 \pm b} \approx a \pm \frac{b}{2a}$$

If for example, the exact value of 23,824 is needed, find in the column "Square of Numbers" (n^2) of the tables, that $(154)^2 = 23{,}716$, which is the smallest value near to the desired number, so it might be written:

$$\sqrt{23824} = \sqrt{23716 + 108} \approx 154 + \frac{108}{308} = 154.35$$

Applying this approximation, an error may be committed of

$$H < \frac{b^2}{8a^3}$$

which in case of the example, is

$$H < \frac{(108)^2}{8(154)^3} \approx \frac{10^4}{10^7} = 10^{-3}$$

Normally, this approximation will produce five-digit accuracy.—I. M. Sors, *engineer, Welwyn Garden City, Hertsfordshire, Eng.*

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables or photos to: Tips and Techniques Editor, Machine Design, Penton Bldg., Cleveland 13, O.

A rapid method for calculating

IRREGULAR AREAS

By **WILLIAM G. FLANNELLY,** Stress Engineer
Kaman Aircraft Corp.
Bloomfield, Conn.

THE method described here may be used to find the area of any plane figure. No equipment other than an ordinary scale, or standard graph paper, is required. In most cases this quadrilateral method is faster than rectangular approximations or approximate integration such as by the trapezoidal rule, Durand's rule, Simpson's rule, Weddle's rule, etc. It is also more rapid than planimetering, especially in the case of large figures. Accuracies of the order of 99.7 per cent are common with this method.

To find the area enclosed by a curve, such as that in Fig. 1, the outline is approximated with any number of straight-line segments of any desired length each. Heavy lines are drawn between terminals of segments, dividing the area into quadrilaterals. An occasional triangle may be included to make the quadrilaterals of convenient size. A light line is drawn with a scale along one diagonal of each quadrilateral, and its length, d, is measured and listed as in Fig. 1. The length of one side of each of the separate triangles (in this case, 1 and 9) is also listed as a length, d. Then the perpendicular distances, h and h', are measured from the diagonal to vertices of the quadrilateral, and perpendicular distance, h, is measured for each of the separate triangles. These values are listed next to their corresponding d values. The area enclosed by the figure is found by summing the area of each of these components, as follows:

$$A = \frac{1}{2} \Sigma\, d(h + h')$$

In the table in Fig. 1, although d_1 and d_9 are the bases of triangles, they may be considered as the diagonals of quadrilaterals whose h' values are zero.

With the outline drawn on tracing paper, a piece of standard graph paper can be used as an underlay to facilitate measurement of the quadrilateral as shown in Fig. 2. If it is often necessary to measure the areas of irregular figures on prints and other opaque media, a form such as in Fig. 2 may be constructed on tracing paper and used as an overlay.

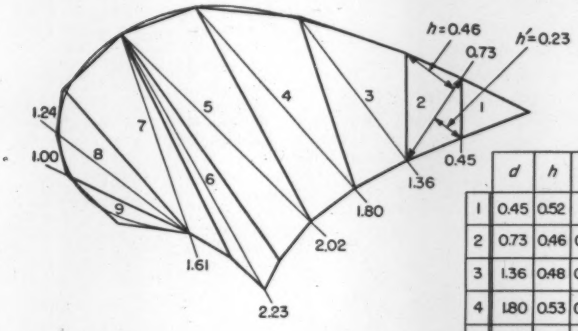


Fig. 1—Irregular area divided into quadrilaterals. Area of each quadrilateral is found as the sum of areas of two triangles with a common base.

	d	h	h'	$d(h+h')$
1	0.45	0.52	—	0.234
2	0.73	0.46	0.23	0.502
3	1.36	0.48	0.42	1.220
4	1.80	0.53	0.42	1.710
5	2.02	0.37	0.53	1.815
6	2.23	0.21	0.10	0.690
7	1.61	0.25	0.52	1.240
8	1.24	0.30	0.20	0.620
9	1.00	0.17	—	0.170
	Total			8.201
	Area			4.100

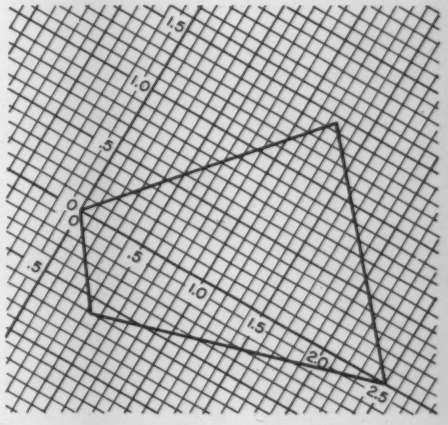


Fig. 2—Standard graph paper used as underlay to find area of quadrilateral. When a vertex of the quadrilateral is placed on the origin with a diagonal lying along the horizontal scale, diagonal length and altitudes may be read directly: $d = 2.5$, $b = 1.45$, and $b' = 0.6$.

Standardized notation for and classification of

Four-Bar Linkages

By BRUCE L. HARDING
Mechanical Design Engineer
Borematic Engineering Dept.
Heald Machine Co.
Worcester, Mass.

The entire system for notation and classification of the four-bar linkage has a mathematical basis, but is so simple that, in most cases, it can be applied merely by visual inspection of a given linkage system

BY VARYING the proportions of the four-bar linkage, an infinite number of mechanisms are produced. The factor of major interest in mechanical applications of the four-bar linkage is whether or not a given linkage can accept and/or produce continuous rotary motion. A system of classification based upon this criterion presents a standardized method of notation so that general equations can be written to define the method.

Linkage Motion: To achieve an understanding of the four-bar linkage, one should ignore its physical form and consider it only as a jointed quadrangle. Fixing each side in turn changes the absolute motions of the moving sides. Relative motions between the sides remain unchanged regardless of which side is fixed or how the figure is oriented in space.

System of Notation: The following system of notation is based upon the four constants peculiar to any given jointed quadrangle; namely, its four sides. It makes no assumptions regarding physical form or orientation of the figure, and is simple enough to be applied by visual inspection of the figure.

Fig. 1 shows a jointed quadrangle. It is notated according to the following procedure:

1. Divide the figure into two pairs of opposite sides.
2. Add the lengths of the sides in each pair.
3. Call the pair with the greater total length the major pair.
4. Call the pair with the lesser total length the minor pair.
5. Sides a and c are the longer members of the major and minor pairs of sides respectively.
6. Sides b and d are the shorter members of the major and minor pairs of sides respectively.

This procedure gives each side of the figure a meaningful designation. The following inequalities can be stated as a result of this notation:

$$a + b > c + d \quad (1)$$

$$a > b \quad (2)$$

$$c > d \quad (3)$$

These relationships are valid for any quadrangle notated in the prescribed manner, and are useful in formulating equations.

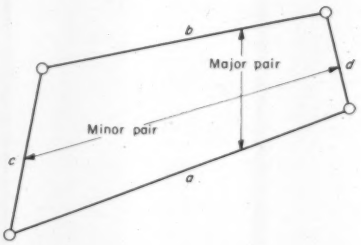


Fig. 1—Pairing the sides of a quadrangle. A simple relationship between the four sides divides all quadrangles into two major groups. If the difference in length between members a and b is less than the difference in length between members c and d, the linkage belongs to Class 1. If the difference in lengths is greater, the linkage belongs to Class 2. Class 1 linkages can accept and/or produce continuous rotary motion but Class 2 linkages cannot.

System of Classification: One extremely simple relationship between the four sides divides all quadrangles into two major groups or classes. This relationship can be determined in most cases by visual inspection of the figure.

Determine the difference in length between the two members of the major pair, the difference in length between the two members

of the minor pair, and compare these differences. If

$$a - b < c - d \qquad (4)$$

the linkage belongs to Class 1. If, however,

$$a - b > c - d \qquad (5)$$

the linkage belongs to Class 2.

Linkages belonging to Class 1 can accept and/or produce continuous rotary motion, but those belonging to Class 2 cannot. In Class 1 linkages, link d is always the shortest link and rotates continuously relative to each of the other three. Links a, b, and c each rotate relative to link d, but only oscillate relative to each other.

Inversions: Though four - bar chains are occasionally elements of complex mechanisms in which none of the four links is fixed, they usually appear by themselves and have one fixed link. Each of the four links in turn may be considered stationary, yielding four different mechanisms, or "inversions," from the same four-bar configuration. Adoption of standardized link notation permits application of meaningful titles to each inversion. A logical method of inversion designation is as follows:

First inversion, link a is fixed.
Second inversion, link b is fixed.
Third inversion, link c is fixed.
Fourth inversion, link d is fixed.

Class 1 Inversions: First and second inversions present a mechanism called the "rotor and rocker" mechanism, Fig. 2, which produces a rotary oscillation from a continuously rotating input, or vice versa. The only operational difference between the two inversions is that the times required for the forward and return strokes of the oscillating crank are generally more nearly equal for the first inversion than for the second, assuming a constant-speed input.

In the third inversion, Fig. 3, both cranks oscillate, but the coupler can rotate continuously. By means of a flexible drive to the coupler, two simultaneously oscillating outputs are generated. This might be useful in linkage computers or where it is required to solve simultaneously two functions having the same independent variable.

The fourth inversion, Fig. 4, is the so-called "drag link" mechanism, herein called the "double rotor" mechanism. It produces a continuously rotating output of varying speed from a continuously rotating input of constant speed.

Class 2 Inversions: Since, in Class 2, all links oscillate relative to each other, all four inversions present the same type of mechanism, namely, the "double rocker" mechanism. There is, therefore, little need for elaboration.

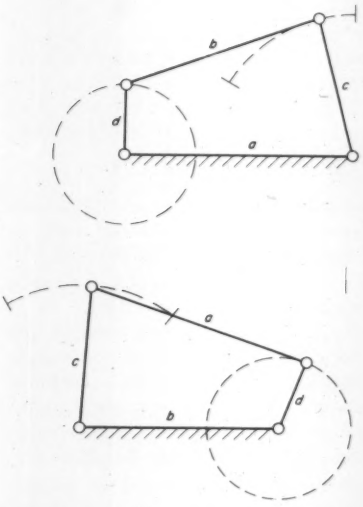


Fig. 2—A rotor and rocker mechanism produced by first and second inversions of a Class 1 linkage. The mechanism produces a rotary oscillation from a continuously rotating input, or vice versa.

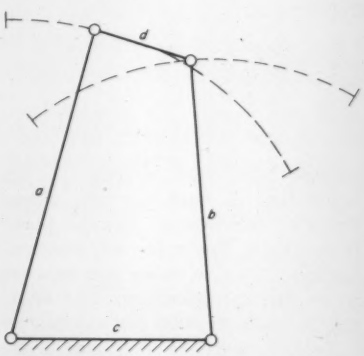


Fig. 3—Third inversion of a Class 1 linkage. Both cranks oscillate but the coupler can rotate continuously. Two simultaneously oscillating outputs are generated by means of a flexible drive to the coupler.

Types of Four-Bar Linkages: Many engineers choose to describe a four-bar linkage according to the motions of its cranks since these are usually the members which receive and produce input and output motions. A crank can either oscillate or rotate continuously, and these two motions can be combined to give three types of mechanism:

Type 1 — Rotary-oscillating, Class 1—1st and 2nd inversions
Type 2 — Oscillating - oscillating, Class 1—3rd inversion, Class 2—all inversions
Type 3—Rotary-rotary, Class 1—4th inversion

Pivot Notation: When links of a four-bar linkage have been notated in the suggested manner, pivots also may be notated systematically as described in the following:

1. If a and b are cranks, let A and B be their moving pivots and O_a and O_b their fixed pivots, respectively.
2. If c and d are cranks, let C and D be their moving pivots and O_c and O_d their fixed pivots, respectively.

Instantaneous Centers: The proposed system of notation can be extended to provide standardized notation for instantaneous centers. The following system is suggested:

Instant center of links a and b, P_{ab}, major pole.
Instant center of links a and c, P_{ac}.
Instant center of links a and d, P_{ad}.
Instant center of links b and c, P_{bc}.
Instant center of links b and d, P_{bd}.

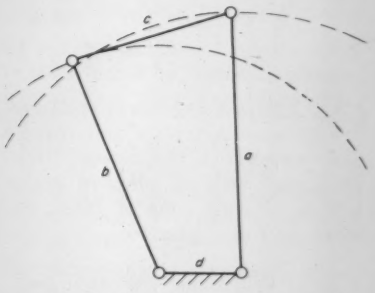


Fig. 4—Fourth inversion of a Class 1 linkage. The drag link, or double-rotor, mechanism produces a continuously rotating output of varying speed from a source of continuously rotating input of constant speed.

Instant center of links c and d, P_{cd}, minor pole.

The symbol P represents the term "pole" which is synonymous with "instantaneous center" and is used universally in prominent European literature. The symbol O, commonly used in current American literature, is easily confused with pivot notation such as O_a, O_b, etc.

A four-bar linkage has six poles. Four poles are pivots—two moving and two fixed; the other two relate the members of the major and minor pairs, P_{ab} and P_{cd}. These two poles might be referred to as the "major" and "minor" poles if such distinction is desired.

Numerical Notation: Procedures of linkage synthesis require numercial notation of the phases (positions) of a linkage, especially when algebraic methods of solution are employed. If numerical notation of phase were to be coupled with numerical notation of links, pivots, poles, and so on, the result would be quite confusing. It is therefore suggested that numerical notation be reserved for phase designation only.

Constructional Limitations: Equations 1 through 5 are sufficient for the analysis of any given four-bar linkage. When synthesizing a four-bar chain, however, it is possible to create a configuration mathematically which cannot be constructed physically. This situation occurs when one side is greater than the sum of the other three and the quadrangle cannot be closed. The following discussion shows how this condition can be avoided.

Four inequalities can be stated for feasible linkages:

$$a - b < c + d \qquad (6a)$$

$$a - b > -c - d \qquad (6b)$$

$$a + b > c - d \qquad (6c)$$

$$a + b > -c + d \qquad (6d)$$

Equations 6b, 6c, and 6d are satisfied by equations 1, 2, and 3 which define standardized notation. Equation 6a is satisfied by equation 4, which defines Class 1, but not by equation 5 which defines Class 2.

Since all four conditions are met in the definition of Class 1 and standardized notation, no precautions are necessary with this group; any linkage satisfying the conditions of Class 1 can be built.

When designing linkages belonging to Class 2, equation 6a must be considered. This condition may be coupled with equation 5 to provide a more complete definition of Class 2. The combined equation is

$$(a - b - c) < d \qquad (7)$$

Special Cases: When the total lengths of the two pairs of opposed links are equal, no distinction can be made between major and minor pairs. It is suggested that the shortest link be notated link d and the other three accordingly, i.e., link c opposite link d, and link a longer than link b. When all four links are equal in length, notation is entirely arbitrary.

When $a - b = c - d$, continuously rotating relative motion is possible. Therefore, such linkages may be considered as members of Class 1. However, they do not usually form practical mechanisms.

From a paper entitled "Proposed Standardized System for Notation and Classification of the Four-Bar Linkage," presented at the ASME Fall Meeting, Hartford, Conn., September, 1957.

Welding Cellular Plastics

by dielectric heating techniques

By **IVAN H. SCHWARTZ**
Thermatron Div.
Radio Receptor Co. Inc.,
New York, N. Y.

CELLULAR plastics are relatively new materials and require new methods of fabrication. High-frequency welding plays a major role in joining some of these cellular, or foam, plastics.

Basic Principles: Dielectric heating describes a method of heating nonconducting materials which have suitable electrical and physical properties. It operates on the principle of converting high-frequency electrical energy to its equivalent in heat energy. Since energy conversion takes place throughout the mass of material heated, transfer losses are reduced to an absolute minimum and heating is uniform and instantaneous.

Development of heat in a dielectric material is brought about by molecular friction. Molecules within the material are subjected to periodic stress caused by an electrical field alternating in polarity several million times per second. Amount of heat developed is proportional to the amount of radio frequency applied to it. Loss factor of the material is the rule of thumb as to whether any particular material can be heated by high-frequency methods.

Materials Selection: Materials having a small loss factor, such as polystyrene, are impractical to heat by high-frequency methods, while vinyls are excellent. It is the instantaneous response of the material that makes dielectric welding so economical. Polyurethane foams respond poorly, but polyether foams show great promise in adaptability to high-frequency fabrication.

Economies: While mold-forming and cementing in foam fabrication are acceptable methods, they do not approach the produc-

New nylon gun body is made in one piece, integrating three former parts in one. It weighs only 5 ounces—is easy to handle, easy to clean. Flashing, buffing and plating are eliminated because the smooth, black finish is *in* the nylon.

Chicago Molded helps develop nylon body for new

Sears-Roebuck paint spray gun...

- that's 66% lighter
- practically indestructible
- tighter sealing than die cast aluminum
- eliminates several machining, polishing and plating operations

This new spray gun will help the do-it-yourselfer to do a more professional job. The entire unit—made by the Electric Sprayit Division of Thomas Industries Inc.—offers home hobbyists new ease of cleaning, ease of handling and greater durability. Models of this new spray gun will be offered by Sears-Roebuck under the Craftsman label, and by independent stores under the Sprayit name.

The behind-the-scenes story is the new application of nylon (Du Pont's Zytel) developed after nearly two years of cooperative research by engineers of Chicago Molded, Electric Sprayit and Sears. By injection molding the entire gun mechanism in a single cavity, several machining, polishing, buffing and plating operations normally required for metal guns have been eliminated. At the same time, the finished product is two-thirds lighter—an important fatigue factor in spraying. And the nylon-to-metal screw threadings make tight seals, guard against leakage of compressed air. Furthermore, nylon is not affected by common solvents, greases, alkalis or oils, and dried paint does not tend to stick to its smooth, lustrous surface.

Whatever your new product needs, you'll find it pays to call in Chicago Molded. CMPC engineers keep abreast of developments in all plastics to help you make your product more saleable, yet less costly. *That's why 66% of our business comes from firms we've served for over 20 years.*

Write today for a free subscription to Plastics Progress, Chicago Molded's data-packed magazine on up-to-date developments in plastics.

Chicago Molded Products Corporation

1028 North Kolmar Avenue, Chicago 51, Illinois

tion possibilities of fabrication from sheet or slab stock. Where combined fabrication operations are required, high-frequency welding makes possible savings in time, space, and labor, and improves product quality because of close control and uniform processing of the materials.

Application: A good weldable foam will weld not only to itself but to vinyl film and sheeting, and even to supported vinyl fabrics. Some nonweldable foams have been used in conjunction with high-frequency welding by sandwiching the foam between two welded vinyl sheets. Some foams, such as a vinyl foam, will weld to vinyl plastic, while others will only adhere or, in some cases, deteriorate the plastic at the point of seal. Therefore, choice of foam for any particular item must be based on type of fabrication.

Production Factors: There are a number of considerations in handling foam fabrication by high-frequency welding. The foam must be sealable and must flow when subjected to high frequency. Die design must incorporate counter pressures by means of springs or rubber, or by Bakelite pressure devices along the welding seams. This is an absolute necessity, particularly in thicker foams, to avoid tearing away the molten foam adjacent to the seam.

It is recommended that the die be wide and the tear seal, when used, be backed up by a nontear seal. After the welding cycle, a cooling cycle of a few seconds must be provided to avoid weakening and bursting the seal and area adjacent to the seal when pressure is released. Additional consideration must be given to occasional irregularity in foam structure. However, while this is not critical until irregularities become excessive, some median point must be determined in adjustment of equipment that encompasses both high and low density areas in the foam.

Rigid Cellular Plastics: In structural applications where sandwiched panel construction is used, high-frequency welding is a positive speedy way of drying or curing the bonding agent without harming the rigid foam or its laminated surface. For example, appliance cabinets are assembled by high-frequency curing of epoxy resins in the assembled joints.

From a paper entitled "High-Frequency Welding of Cellular Plastics," presented to the Cellular Plastics Div. Conference of The Society of the Plastics Industry Inc., New York, October, 1957.

Synchro Systems

By **HARRY ROSENBERG**
Bureau of Ships
Dept. of the Navy
Washington, D. C.

SYNCHROS have a wide range of applications where angular information must be transmitted electrically. They also serve as error detectors in numerous types of servomechanisms. A simple synchro system consists of a synchro transmitter and a synchro receiver connected as shown in Fig. 1. When the shaft of the transmitter is turned, the rotor of the receiver turns through the same angle.

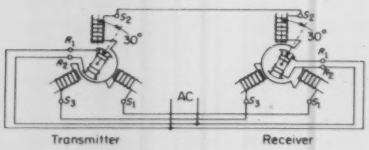


Fig. 1—Simple synchro system. When the transmitter shaft is turned, the receiver rotor turns through the same angle as the transmitter rotor.

Synchros look like small ac motors in that they consist of a stator and rotor. The stator consists of a number of coils, wound in slots around the inside of a laminated iron field structure. Typical coils are divided into three groups, spaced 120 degrees apart. The rotor is mounted on ball bearings and is provided with two slip rings.

A synchro transmitter or receiver acts essentially as a transformer. When an ac voltage is applied to the rotor, single-phase voltages are induced in each of the three stator coils. The magnitude of each stator voltage depends on the position of the rotor, and any rotor position determines a set of three stator voltages.

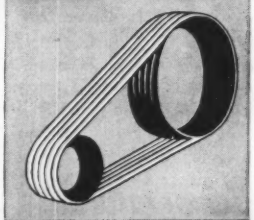
Synchro Differential: If it is desired to transmit or indicate an angle equal to the sum or difference of two angles, a synchro differential may be used. Differential transmitters and receivers differ only by the inertial dampener mounted on the shaft of the receiver.

When stator leads of a differential are connected to corresponding stator leads of an energized transmitter, the three voltages induced in the rotor coils of the differential correspond to those voltages that would be induced in the transmitter corresponding to its actual rotor angle minus the rotor angle of the differential.

By connecting a transmitter and differential transmitter to a receiver, Fig. 2, an angle equal to the difference between the angle of the transmitter rotor and differential transmitter rotor is assumed by the receiver rotor.

If a differential receiver is connected to two transmitters, the rotor of the differential receiver assumes an angle equal to the difference between the angles of the two transmitter rotors. By interchanging leads between the units, it is possible to obtain different relationships between the rotor angles. Possible combinations are shown

TEXROPE



DRIVES

NEW adjustable-speed Magi-Key SHEAVE

- positive locking
- greater design hp capacity

Here's an entirely new Allis-Chalmers concept in cast iron adjustable sheave design. It's the newest member of the *Texrope* drive family, the *Magi-Key* sheave!

This new sheave makes it really easy and inexpensive to obtain variable speeds on low-horsepower applications. Here's why:

- ✓ Handles design horsepower applications from fractional to 13 hp.
- ✓ Features positive locking between sheave and shaft.
- ✓ Has combination keylock from disc to hub . . . no more fumbling to get proper tightening.
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- ✓ Key lock won't slip — setscrew can't fly out.

Magi-Key sheaves are available in one and two-groove sizes for either A or B section V-belts. Find out more from your A-C district office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

HERE'S THE KEY. This combination keylock from disc to hub makes adjustment easy.

Texrope and *Magi-Key* are Allis-Chalmers trademarks.

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Circle 470 on Page 19

in schematic in Fig. 3.

Control Transformer: The major disadvantage of synchro receivers is that they produce only small torques. They are, therefore, mainly used to position dials or pointers. When greater torques are required, a synchro control transformer may be used as the input to a servomechanisms system as shown in Fig. 4.

The stator of a control transformer is similar to that of a synchro receiver or transmitter, except that winding resistance is much higher. The rotor winding is distributed in slots in the rotor, and the two ends are connected to slip rings.

When a control transformer is connected to a transmitter, stator voltages of the transmitter and control transformer are equal, and the magnetic fields of the two synchros are identical. The magnetic field produced in the transmitter is parallel to the transmitter rotor, so that the magnetic field of the control transformer is also parallel to the transmitter rotor.

Transformer Application: Voltage induced in the control transformer is a sinusoidal function of its position of the rotor coil axis with respect to the magnetic field. It is zero when the rotor is at right angles to the field. This rotor voltage can be amplified and applied to a servomotor. The servomotor will then position the control transformer until its output voltage is zero, or when the axis of the coil of the control transformer is at right angles to the axis of the coil of the transmitter rotor.

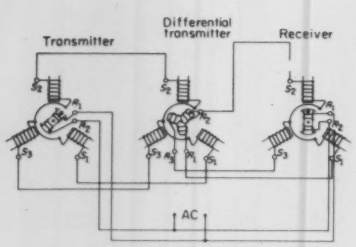


Fig. 2—Transmitter and differential transmitter connected to a receiver. The receiver rotor assumes an angle equal to the difference between the angle of the transmitter rotor and differential transmitter rotor.

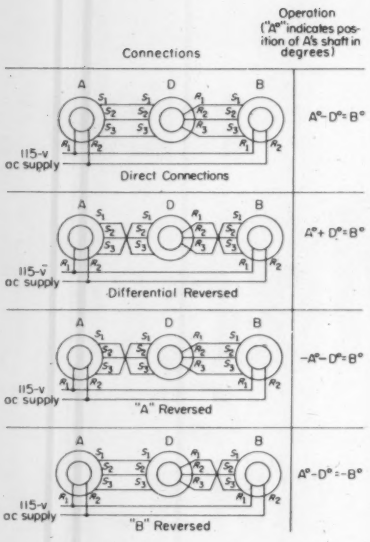


Fig. 3—Rules for a differential with various connections. Different relationships between rotor angles are obtained by interchanging leads between units.

Transmitters and differential transmitters intended for use with control transformers are called transmitters and control differential transmitters. Transmitters and differential transmitters used to position synchro receivers are generally referred to as torque transmitters and torque differential transmitters.

Control transformers and differentials draw continuous stator current which is highly inductive. To reduce this current and improve the accuracy of the system, synchro capacitors are connected across the stator leads of control transformers and differentials. The three capacitors required for each synchro are in a single enclosure and are provided with three external connections.

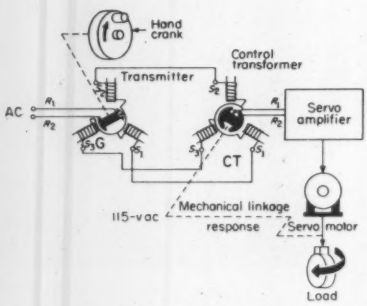


Fig. 4—Synchro control transformer used as input to a servomechanism system. Arrangement produces increased torque for applications other than positioning of pointers and dials.

From "Synchros—Use, History, and Description," in Bureau of Ships Journal, *October,* 1957.

High-Temperature Bearing Lubricants

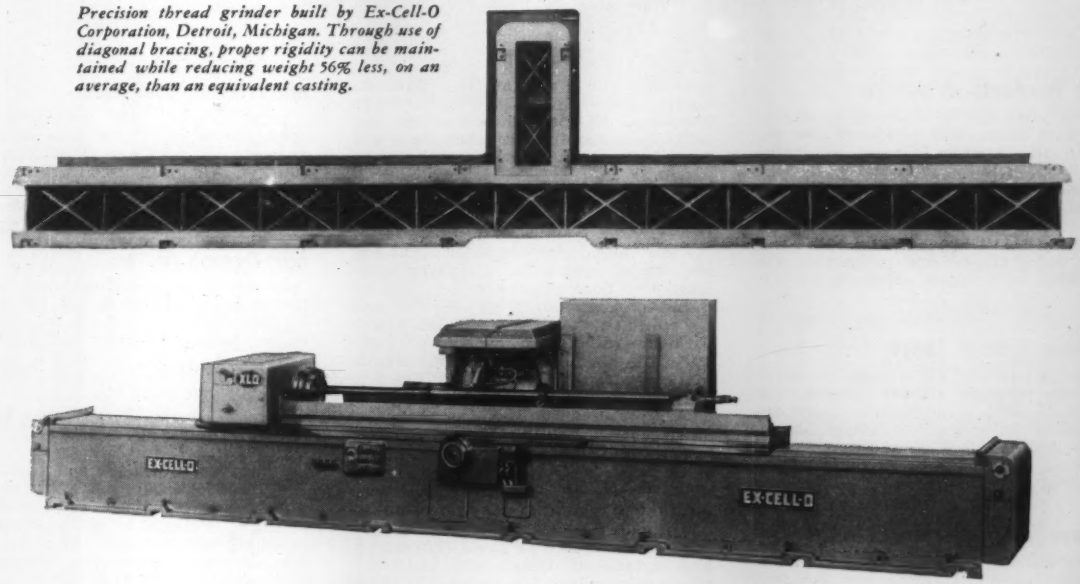
SLIDING and rolling-friction tests conducted with liquid, gaseous, and solid lubricants in both air and inert atmospheres at temperatures to 1000 F showed the following results:

1. Inert atmosphere extends temperature limitation of liquid lubricants appreciably. Exclusion of oxygen results in successful bearing operation at 850 F with low-viscosity mineral oil.
2. Gaseous lubricants, such as chlorine-substituted methane, are effective boundary lubricants when the number of active chlorine atoms is sufficient to form chloride film on the surfaces.
3. Effective lubrication can be maintained with solid lubricant in an inert atmosphere even after harmful oxidation products are formed by using bearing materials which are not affected by products of oxidation.
4. Graphite lubricates various metal combinations effectively at 100 and 1000 F but not at all intermediate temperatures. Effective lubrication is possible when an adsorbed water-vapor film is present, or an oxide film of the proper type is present continuously on lubricated surfaces. This hypothesis presumes effective lubrication at all intermediate temperatures provided that the graphite can be maintained between sliding surfaces.
5. Certain mixtures of oxides or salts of soft metals and graphite improve adherence of the mixture to metal surfaces and prowide effective lubrication at temperatures to 1000 F.

From ASME paper 57-LUB-1 entitled "On Friction and Lubrication at Temperatures to 1000 F With Particular Reference to Graphite," by E. E. Bisson, R. L. Johnson, and W. J. Anderson, presented at the ASLE-ASME Lubrication Conference, Toronto, October 1957.

CUTTING COSTS AND WEIGHT WHILE DESIGNING FOR GREATER RIGIDITY

Precision thread grinder built by Ex-Cell-O Corporation, Detroit, Michigan. Through use of diagonal bracing, proper rigidity can be maintained while reducing weight 56% less, on an average, than an equivalent casting.



THIS precision thread grinder because of its great length in relation to width is particularly subject to twist as inertia is transferred from the work to the machine.

To achieve sufficient rigidity without resorting to a base of monstrous size and weight, welded steel is used.

This is possible because steel is 3 times stronger and 2½ times more rigid than gray iron. Costs are reduced because less material is needed, welding is fast, and welded bases require less machining and finishing.

Wherever welded steel is being used to improve products and to cut costs you'll find Lincoln arc welding products. Lincoln has pioneered the development of more efficient welding through better machines and electrodes—at less cost!

DESIGNERS! ENGINEERS!

Lincoln makes these aids available to help you with design problems.

Machine Design Sheets sent free to engineers and designers. "*Procedure Handbook of Arc Welding Design and Practice*"—1300 pages, 1100 illustrations, 240 pages on machine design. $3.00 postpaid in U.S.A., $3.50 elsewhere. *Machine Design Seminars* conducted at our Cleveland plant. Write for information.

LINCOLN

THE LINCOLN ELECTRIC COMPANY
DEPT. 1127 • CLEVELAND 17, OHIO
The World's Largest Manufacturer of Arc Welding Equipment

When steel is 3 times stronger

Has 2½ times the rigidity

Yet costs ⅓ as much as iron

WHY use anything but welded designs?

Circle 471 on Page 19

Helpful Literature
for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Mill Products & Alloys

Mill products of aluminum, titanium, and other mill products are detailed in Technical Brochure "Mill Products and Alloys." Range of shapes, sizes, and alloys is covered. Light and heavy press extrusions, press and hand forgings, and impact extrusions are among products. Design data, alloys, and properties are included. 12 pages. Harvey Aluminum.

Circle 601 on Page 19

Sponge Rubber Sheet

Properties of Cohrlastic R-10470 silicone sponge rubber sheets for −100 to 480° F applications are detailed in data sheets. These sheets meet AMS 3195, 3196 and many commercial specifications. 2 pages. Connecticut Hard Rubber Co.

Circle 602 on Page 19

Power Transmission Belting

Significant applications of Extremultus power transmission belting, made of polymer and chrome tanned leather, are shown in catalog. Sections are provided on selection of proper belt type, tensioning and maintenance, and bearing load reduction. Extremultus, Inc.

Circle 603 on Page 19

Liquid Gages & Valves

An easy-to-use working tool for the engineer, Catalog 305 shows standard and special function gages and valves, and provides dimensional drawings, construction features, pressure-temperature graphs and ratings, materials, and tables of sizes. 8 pages. Jerguson Gage & Valve Co.

Circle 604 on Page 19

Clutches & Brakes

Complete data are supplied in brochure on the new Simplatrol line of electric clutches and brakes in larger sizes. Drawings cover clutch coupling, electric clutch, combination clutch and brake, electric brake, and duplex clutch styles, plus the combined sheaves-clutch design. 4 pages. Simplatrol Products Corp.

Circle 605 on Page 19

Zirconium

Applications and properties of commercial-grade zirconium metal is subject of technical digest. Booklet reviews established and potential applications for zirconium, gives corrosion and physical properties, and discusses methods of fabrication. Columbia-National Corp.

Circle 606 on Page 19

Screw Machine Products

Typical Allmetal screw machine work in a variety of tough alloys including stainless steels, Inconel, nickel, and titanium are depicted in brochure. Fabrication operations and techniques required for each item are described. 4 pages. Allmetal Screw Products Co.

Circle 607 on Page 19

Air & Hydraulic Cylinders

Dimensional drawings on eight air and eight hydraulic cylinders with tabulated bore sizes are provided in bulletin. Bore sizes of ¾, 1, and 1⅛ in. are covered. Air units are pressure rated to 200 psi, hydraulic units, to 2000 psi. 4 pages. Pneumatic-Hydraulic Development Co.

Circle 608 on Page 19

Twin Screw Pumps

Technical Bulletin 255 features twin screw pumps for noncorrosive liquids of wide viscosity range at pressures up to 350 psi and capacities up to 550 gpm. Selection nomograph, outline dimensions, sectional drawing, and details of design and construction are provided. 6 pages. Warren Pumps, Inc.

Circle 609 on Page 19

Electro-Magnetic Clutches

Style E, Class M electro-magnetic clutches for ball mills, rod mills, Compeb mills, kilns, and other heavy duty applications are described as to dimensions and other vital information in Bulletin 501. Torque-load formulas and other selection data are given. 4 pages. Stearns Electric Corp.

Circle 610 on Page 19

Waterproof Footswitch

The Nautilus footswitch described in bulletin is waterproof, dustproof, oilproof, and rustproof. Piston type actuator is sealed with an O-ring. Momentary and maintained contact models are offered. 2 pages. Linemaster Switch Corp.

Circle 611 on Page 19

Steam Heating Coils

"Westinghouse Heavy Duty Steam Heating Coils" is title of Catalog 1715 which gives selection data and suggested piping arrangement, as well as diagrams and description of this heavy wrought iron heating coil. 12 pages. Westinghouse Electric Corp., Sturtevant Div.

Circle 612 on Page 19

Primary Elements

Primary Elements Catalog No. 1 contains listings and data of all forms of primary elements, includes information on forged and fabricated orifice plates and flow nozzles, and cast and fabricated Venturi tubes. Burgess-Manning Co., Penn Instruments Div.

Circle 613 on Page 19

Motor Generator Sets

Synchronous and induction 400-cycle motor generator sets described in Form MG.9-57 are rated from 1 to 200 kw. All units listed are designed for continuous duty at 40° C. 4 pages. Kato Engineering Co.

Circle 614 on Page 19

FHP Geared Motor

Standard stock fractional horsepower gear reducer motor model SG-15 described in Form 6 is available in 16 output speeds ranging from 1 rpm at 15 lb in. to 300 rpm at 1.2 lb in full load torque. 2 pages. Merkle-Korff Gear Co.

Circle 615 on Page 19

Conveyor Pulleys

Improvements have been made to the major portion of HD conveyor pulley line to meet improved belt ratings. Pulleys have "built-for-the-belt" ratings without help from oversize shafts. Descriptive information is provided by Catalog CP-57. American Pulley Co.

Circle 616 on Page 19

Rotary Pumps

Features, ratings, and dimensions relative to Type GAR heavy-duty rotary pumps are provided in Form 2064-B1. Pump capacities range to 25 gpm with pressures to 500 psi. 6 pages. Worthington Corp.

Circle 617 on Page 19

Metal Molding

Configuration data and dimensional information on rolled metal molding is effectively presented in plastic-bound color Brochure 10C entitled "John Lees Keeps You in Trim." Trim is offered in stainless steel, aluminum, finished stainless and finished aluminum, as well as patterned stainless and aluminum. Attaching techniques are well illustrated. 68 pages. Serrick Corp., John Lees Div.

Circle 618 on Page 19

Instrumentation Systems

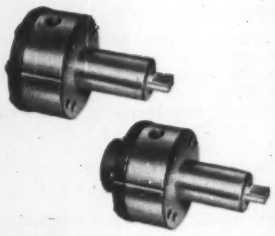
Gilmore autographic plotter, electric force measuring systems, and electric scales are described in Bulletin 1001. Systems are used in industry to measure weights, force, pressure, temperature, and motion. 4 pages. Gilmore Industries.

Circle 619 on Page 19

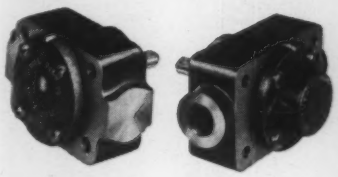
Instant-Reversing Motors

Full torque capacity of Inst-O-Verse motors is instantly utilized for reversing. Reverse is instantaneous because reversing device is automatically preset by shaft rotation. Inst-O-Verse motors are available through 1 hp ratings as single-phase,

NOW! Have Reliable Lubrication at Minimum Cost

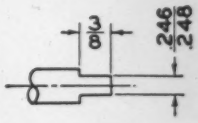


Models LF and RF
Capacities 55-170 g.p.h. at 1800 r.p.m.
Designed for flange mounting without shaft seal; with *choice* of internal or external porting. Model RF has automatic reversing feature which permits driving the pump in either direction... without changing direction of flow or port positions.

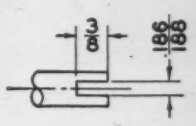


Models LFD and RFD
Capacities 60-180 g.p.h. at 1800 r.p.m.
Designed for non-directional service; for flange mounting with internal porting. Variations for external porting and/or shaft seal are shown below. Model RFD has the automatic reversing feature which permits driving the pump in either direction... without changing direction of flow or port positions.

ALTERNATE SHAFT DRIVE ENDS
For All Models



MODIFICATION "A"



MODIFICATION "B"

Tuthill "Cartridge-Type" Pumps Solve This Problem for Plant Maintenance...and Original Equipment Manufacturing

Durable—Reliable—and Available from Stock!

1. The demand for minimum cost lubrication pumps without sacrifice in performance, durability and reliability is *ideally* satisfied by the TUTHILL series of Models LF, RF, LFD and RFD *cartridge-type* pumps.

2. TUTHILL "cartridge" pumps get their reputation as cost-savers from their special design for original equipment use, their durable construction, their reliability...and the fact that they are *available from stock*. Note their compact size as shown in the photos above. Consider how all waste space has been eliminated for more adaptability. Think how they can be easily applied to your *own* requirements...in your plant...or in your equipment manufacturing plans.

3. These variables are available:

a. Pumps with...*or without*...automatic reversing performance

b. Pumps with...*or without*...a shaft seal

c. Pumps with internal...*or external*...porting

d. Pumps with *variations* of both internal and external porting

4. TUTHILL Catalog Section 108 contains line drawings showing each model in detail, shaft rotation and porting arrangements and other vital statistics to help you select the RIGHT model. Fill out the attached coupon—or write.

TUTHILL PUMP COMPANY
953 E. 95th Street, Chicago 19, Illinois

Gentlemen:

☐ Please send me Catalog Section #108
☐ Please send the complete catalog on the Tuthill line
☐ Have your representative call

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

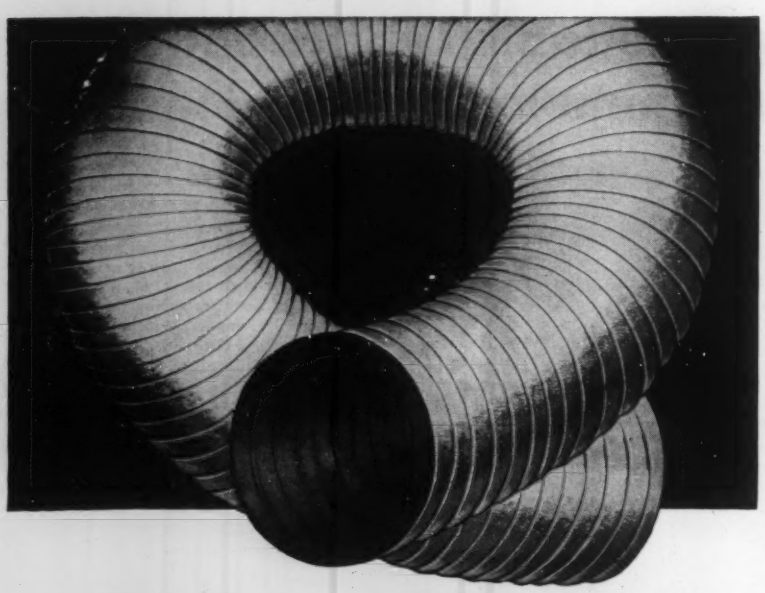
Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities from 1 to 200 GPM, for Pressures to 600 PSI, Speeds to 3600 RPM.

TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois
Canadian Affiliate:
Ingersoll Machine & Tool Company, Ltd., Ingersoll, Ontario, Canada

PUMPS FOR YOUR PURPOSE

Circle 472 on Page 19



facts about Flexflyte®

that will help you solve a ducting design problem

What is Flexflyte?
A lightweight, reinforced ducting made of a spring steel wire helix covered with coated fiber glass or a cotton fabric and bound with a fiber glass cord.

What are its applications?
Equipment designers will find Flexflyte ideal for applications where an unobstructed flow of air, gases, liquids, chemicals, light solids must be maintained.

How flexible is Flexflyte?
It will take tight turns at any point up to 180° without buckling. No elbows or fittings are required.

What are its temperature ranges?
From minus 120°F. to plus 650°F.

What pressures will Flexflyte handle?
Internal working pressures up to 70 psi and external working pressures up to 15 psig.

Is it flame resistant?
Flexflyte has exceptionally high flame resistance and will not support combustion.

What about Flexflyte's resistance to abrasion?
It is highly resistant to abrasion, especially when coated with FT-506 which has more than 200 times the abrasion resistance of any tubing of its type and weight.

What about installation?
Flexflyte is quickly, easily installed around corners and equipment parts by means of metal clamps. It is also available with special enlarging or reducing ends, either cylindrical, rectangular or polyhedral.

Can Flexflyte be engineered for unusual applications?
Yes. Special fabrics, coatings, connections, lengths and diameters are available. Our special Silicone Department, working with automated machinery, is prepared to meet any requirement for silicone ducting.

How can I make sure that Flexflyte will solve my problems?
Write us, outlining your requirements. Our engineers will be glad to put their experience to work for you. Write Dept. 18N.

Flexible Tubing
CORPORATION
GUILFORD, CONN. • LOS ANGELES 64, CALIF.

Circle 473 on Page 19

Helpful Literature

1725-rpm, 115 or 230-v units. They are described in Form P-86011. 4 pages. Franklin Electric Co.

Circle 620 on Page 19

Rotary Solenoids

Ledex rotary solenoids and selector switches are described in Bulletin 756-RS&R. Solenoids are made in 1 to 3⅜ in. diameters, predetermined rotations up to 95 per cent, and starting torques for the 45-degree stroke range from 0.2 to 54 lb-in. 4 pages. G. H. Leland, Inc.

Circle 621 on Page 19

Hydraulic System Components

Directional control valves, accumulators, check valves, tube and hose fittings, O-rings, and gaskets used in hydraulic and fluid systems are descriptively covered in Bulletin 124. 4 pages. Parker-Hannifin Corp., Industrial Hydraulics Div.

Circle 622 on Page 19

Remote Digital Weighing

Company's digital scanner system which accurately records or indicates weights in digital form at any remote location is subject of Form 2975. Electronic counting and translating unit, which transmits weight to card punch machines for tabulation, is shown. Supplementary literature includes data sheets on scale for weights in motion and the electronic Micro-Tester for small springs. 8 pages. Toledo Scale Co.

Circle 623 on Page 19

Hydraulic Fittings

Catalog M-57 introduces the Flodar self-coined, metal-to-metal seal, straight thread hydraulic fitting. Fitting requires no swing radius and is installed with ordinary tools. 4 pages. Flodar Corp.

Circle 624 on Page 19

Motor Control

Front access, high voltage Type H motor starter for 2300 to 5000-v motors is described in illustrated Bulletin 14B8507. Roll-out air-break contactor makes inspection and maintenance easy. An oil-immersed contactor is also available. Unit is 34 in. wide. 8 pages. Allis-Chalmers Mfg. Co.

Circle 625 on Page 19

Industrial Television

Industrial television camera, control, monitors, power supplies, and accessories are described in illustrated catalog PC6582JW. Typical applications are covered and system specifications are given. 8 pages. Philco Corp.

Circle 626 on Page 19

Infinite Control

Infinite number of heat selections over the entire cooking range is provided by this infinite control for electric ranges, subject of illustrated bulletin. Engineering description of the unit is given. 4 pages. Proctor Electric Co.

Circle 627 on Page 19

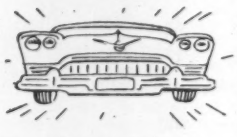
Drafting Machine

How the Glideline drafting machine is used with the drawing board at

Any similarity to a real-life company is purely intentional

How did they use their beans in Boston to cut forming rejects?

A couple of years ago, Otto Motive, super sales engineer of East Boston, Mass., began to eye a new prospect.



Thought he, "As an account, that Supercrate V-8 looks great. They buy a lot of parts. It sure would be peachy—and profitable—to land that plum!"

And, by golly, Otto did get a contract — to furnish wire-wheel units of 25-gauge stainless.

He also got *more* than he bargained for. Sleepless nights, for example. Because — though tempus fugited, production of the wire-wheel units didn't.

It seems that the boys in Otto's shop had trouble forming the hub-cap sections of the units. The stainless scored in the die. Rejects piled up. The scrap pile became something to behold. Delayed delivery dates caused delirium.

Then someone suggested trying dies made from Ampco Metal Grade 24 (a just cause for a raise, if we've ever heard of one!).

Rejects dropped off to practically nothing. Which is no surprise to us. Dies made from Ampco Metal have done as much for many a shop drawing or forming stainless or other clean metals—have made possible real savings.

And they can do as much for *you*. You can count on that!

Ampco Metal dies have an exceptionally low coefficient of friction. They don't load, gall, or scratch the work. They hold close tolerances longer.

You make a better product with fewer costly finishing operations. You cut scrap loss.

You reduce downtime, also. Ampco Metal dies have little or no pickup — you get far longer runs than with steel dies without redressing.

An Ampco stocking distributor near you carries 70 sizes of Ampco Metal die blanks — solid rounds, rectangles, and centrifugually cast rings. Call him.

AMPCO®

If you don't know who your Ampco distributor is, write us for his name. *Ampco Metal, Inc., Dept. MD-11 Milwaukee 46, Wisconsin. (West Coast Plant: Burbank, California).*

AMPCO METAL

The metal without an equal

RM-8

FELLOW VISIONARIANS: K&E Albanene® Tracing Paper keeps your originals clear for life . . . substantially lowers your operating costs.

K&E Albanene has more desirable working qualities than any other tracing paper. Its superiority begins with the stock—100% rag paper with the longest fiber in the business, made only for K&E. This gives Albanene its extraordinary tear strength with the greatest possible transparency. Original drawings stand up year after year under repeated reproductions without damage or loss of clarity.

Albanene is permanently transparentized with an inert synthetic resin exclusive with Albanene . . . accepts pencil and ink equally well. Ink lines never spread or feather. What you pay for stays in the paper.

It will pay you in lower operating costs to specify K&E Albanene®. . . the largest selling tracing paper in the world. For other drafting or engineering equipment and materials also look to Keuffel & Esser Co. —your "Partners in Creating"—who have served engineering for 90 years.

KEUFFEL & ESSER CO. New York, Hoboken, N.J., Detroit, Chicago, St. Louis, Dallas, San Francisco, Los Angeles, Seattle, Montreal.

Helpful Literature

any angle from horizontal to vertical is illustrated in Bulletin GL8P. Instant accurate angle settings can be made with automatic 15-degree indexing. Sizes range from 30 x 42 in. to 48 x 96 in. 2 pages. Glideline Corp.

Circle 628 on Page 19

Transistors

Line of PNP and NPN transistors for radio, radio frequency, and intermediate frequency applications is covered in Bulletin G-120. Four, six, and seven transistor radio kits and their circuit diagrams are also detailed. General Transistor Corp.

Circle 629 on Page 19

Titanium Wire & Rod

"Conversion Table for Titanium Wire & Rod" converts wire diameters from 0.002 to 0.2 in. to lineal feet per pound and round and square bar stock from 1/16 to ¾ in. to pounds per lineal foot. Johnston & Funk Titanium Corp.

Circle 630 on Page 19

Panels & Etched Circuits

Etched, engraved, lithographed, and screened panels and control boards for instruments and electronic equipment are described and shown in brochure. Several examples are shown. Also covered are etched circuits, made by the Etchrite process. 4 pages. Etched Products Corp.

Circle 631 on Page 19

Valves & Controls

Valves and controls for automatic operation of heat pumps are illustrated and described in Booklet 1687. Specifications and operational details are given these and other products, including an automatic de-icer and slide type reversing valves. Capacities range to 7½ tons. 20 pages. Ranco Inc.

Circle 632 on Page 19

Spark-Ignition Engines

Features of Caterpillar spark-ignition engines are covered in illustrated catalog D717. Various applications, including one where operation is on sewer gas, are shown. Mechanical details are explained. 8 pages. Caterpillar Tractor Co.

Circle 633 on Page 19

Calibrator

Technical details, uses, and operation of the Type C calibrator for wire strain gages, their transducers and thermocouples are found in illustrated bulletin. Specifications are included and its controls are detailed. 4 pages. Allegany Instrument Co.

Circle 634 on Page 19

Recessed Letter Paint

Techniques used to fill recessed letters, symbols, and numerals with paint are described in illustrated leaflet. Problems involved with using coatings and dry wipes on second surface clear plastics, machines, and marks are covered. Logo Inc.

Circle 635 on Page 19

Better Welds

"How To Get Better Welds" is a revised vest pocket guide of useful arc welding information. Data on

Experimental block being readied for torture test on Johns-Manville's Inertia Dynamometer—the world's largest unit designed for friction material testing.

Man in charge of putting more mileage into J-M Brake Blocks

Creating new and better brake blocks is a never-ending responsibility of J-M engineers. Working with the very latest in scientific development equipment, these men are blazing new trails in improved friction material performance.

Over the years, Johns-Manville has offered a wide choice of thoroughly proved, high-quality, high-performance brake linings, brake blocks and clutch facings. This superiority stems from engineering and production techniques that assure uniformly highest quality. These techniques also provide volume production, rapid delivery and lowest unit cost.

Chances are a J-M material incorporating all the properties you need for your friction applications is already available. If not, let us help you find the solution. The Johns-Manville engineering staff, a superbly equipped development laboratory, and skill gained through 99 years of manufacturing experience, are at your service.

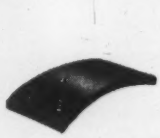
Your Johns-Manville Representative will gladly tell you more about this service, or write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

Molded and Woven Brake Linings

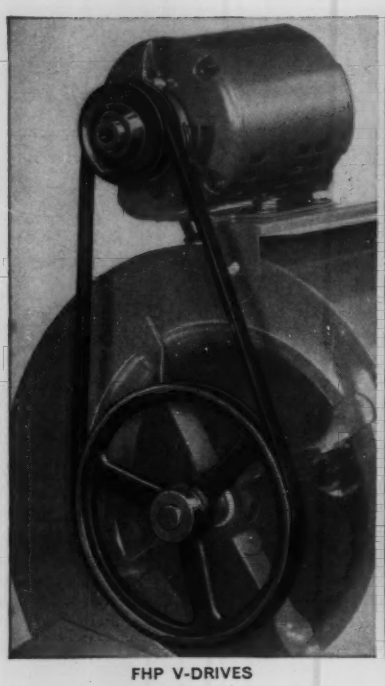
Molded and Woven Clutch Facings



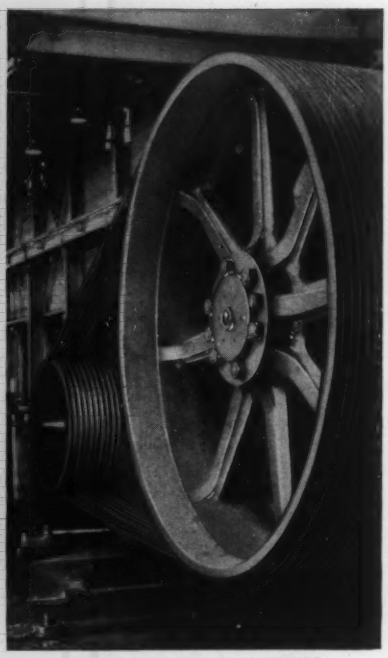
Molded Brake Blocks

Molded Segments for Automatic Transmissions

Woven Transmission Band Linings



FHP V-DRIVES

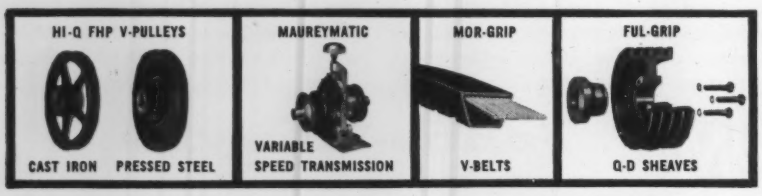


HEAVY DUTY MULTI V-DRIVES

Since 1917...

American industry has approved maurey quality

40 years since 1917 have taught us at Maurey that American industry appreciates quality. Today's complete Maurey V-Drive line reflects that lesson. The Maurey Hi-Q V-Pulley ranks No. 1 in the FHP V-Pulley field on true-running, belt-saving performance and wide industrial use. In the field of heavy duty drives, Maurey Ful-Grip Q-D Sheaves and standard Multi-V sheaves are recognized quality leaders. Every Maurey Mor-Grip V-Belt, and V-Drive accessory is engineered and quality-built to deliver the finest, most dependable V-drive performance your dollar can buy. The free literature listed below will help you to better V-drive performance. Write for it.



For V-Drive Users, Designers

- V-Drive Engineering Manual
- FHP V-Drive Catalog No. F-10
- V-Belt Catalog No. V-55
- Multiple V-Drive Catalog No. MVD-56
- Maureymatic Variable Speed Transmission Catalog No. MM-56

Write for free copies.

maurey MANUFACTURING CORPORATION, 2903-27 S. WABASH AVE., CHICAGO 16, ILL.

Circle 477 on Page 19

Helpful Literature

metals and electrodes, four essentials of proper welding procedures, fillet weld, types of joints, typical welding positions, causes of common welding troubles and what to do about them, and how to select electrodes for various metals are among subjects. 60 pages. Hobart Brothers Co.

Circle 636 on Page 19

Acetal Resin

General purpose injection molding and extrusion compositions are available in Delrin acetal resin, subject of Folder A-3206. Properties include strength, stiffness, wide temperature and humidity ranges, and solvent resistance. Typical properties and uses are given. 4 pages. E. I. du Pont de Nemours & Co.

Circle 637 on Page 19

Sintered Metal Parts

Advantages of Sintaloy powder metal parts, how they are made, and the principles of economical design and production which should be considered are detailed in illustrated booklet 1-457. Characteristics of available powder metal alloys are given and typical parts produced are shown. 12 pages. Dixon Sintaloy Inc.

Circle 638 on Page 19

Fastener Lead Error

Lead error—the deviation in spacing of successive turns of thread—is the major cause of fastener assembly problems in industry, according to illustrated booklet 2294. The anatomy of lead error, its mathematics, most common causes, and means for detecting and preventing it are covered. 16 pages. Standard Pressed Steel Co.

Circle 639 on Page 19

Synchronizing Switch

Rotary synchronizing switch, a mechanical limiting unit described in illustrated Bulletin 33-A, controls starting, stopping, interlocking, time-motion, and sequence and recycling of machine tools and mechanical press auxiliary equipment. All switches in the device can be controlled from 0 to 360 degrees. 4 pages. E. W. Bliss Co.

Circle 640 on Page 19

Gas Thermostat

Heavy duty, high capacity Model CTS gas thermostat, subject of illustrated bulletin RT-815, is for use in commercial and industrial equipment. Snap-acting unit is offered in ranges to 550° F. Natural gas rating is 198,000 Btu. 4 pages. Robertshaw-Fulton Controls Co.

Circle 641 on Page 19

Connector

Specifications, diagrams, and general data on the Continental printed circuit connector for computer applications are content of data sheet. Connector is 9 27/32 in. long and has 34 contacts. 2 pages. DeJur-Amsco Corp.

Circle 642 on Page 19

Capacitors

Subminiature electrolytic capacitors, flat and round miniature Mylar

Design "Low Cost" Into YOUR Equipment

GITS

World's Largest Selection of Low-Cost Lubricating Devices

LUBRIKIT . . . An assortment of 95 oil cups of 29 different types. Gits sales records show these oilers are most used for replacement and maintenance. Contents of each separate bin are clearly described on Inside Cover.

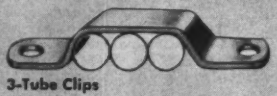
Special Introductory Price
Just **$14.95** F.O.B. Factory
Satisfaction or your money back

CLIPS FOR ATTACHING TUBING

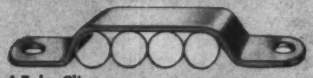
When ordering, specify ¼", ⅜" or ⅜" tubes. Style TF.

Single Clips

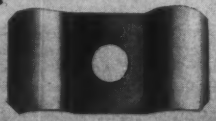
Double Clips



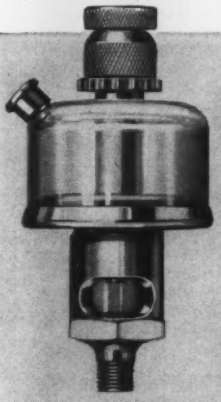
3-Tube Clips



4-Tube Clips

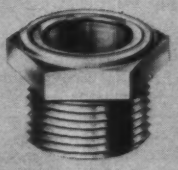


Double Clips — Wing Type



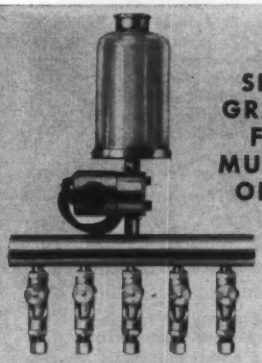
SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem. Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.



GEAR CASE GAUGES

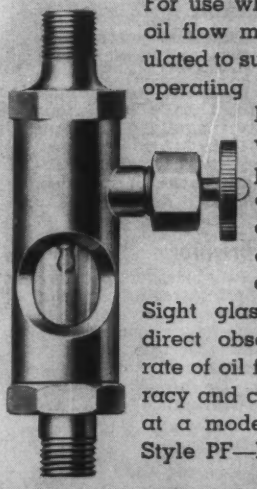
This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.



SIGHT GRAVITY FEED MULTIPLE OILERS

This one unit replaces 3 to 8 individual oilers. Maximum practicality in a small central lubrication system. Positive cut-off during idle periods. Individual vibration-proof needle valve adjustments. With solenoid control (Illustrated): Style MDS—No. 4685-A. Without solenoid: Style MD.

SIGHT GAUGES



For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

Don't price yourself out of the market. When you design proper lubrication into your equipment, specify GITS Lubricating Devices—the widest selection available anywhere. The items pictured above are only a few of our many thousands of lubricating devices. At the design stage, get the GITS story. Free Engineering Service. Send NOW for your free Catalog.

GITS BROS. MFG. CO.

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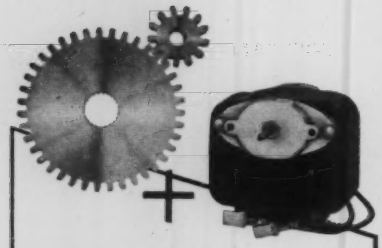
1868-C South Kilbourn Avenue
Chicago 23, Illinois

Clip this page for handy "rough reference"

Circle 478 on Page 19



Perfect Mating of Gearing and Motors

in MERKLE-KORFF GEARED MOTORS

makes certain you get MORE TORQUE PER POUND AND PER DOLLAR

GEARS — 45 years' gear reducer experience is your assurance of rugged, precision hobbed, heat treated *High Efficiency* spur gearing at lowest cost, plus —

MOTORS — *High Output vs Weight*, dependable shaded pole motors, engineered to produce *High Starting Torque*, so important in successful geared motor design, is an unbeatable combination.

Merkle-Korff gear reducer motors have helped many of America's leaders reduce cost while improving their product. We can do the same for you.

From .4 to 300 inch-pounds at 800 to ½ RPM.

Many other speeds and torques above and below this range are available.

Ask for Complete Information

MERKLE-KORFF GEAR CO.

215 N. MORGAN ST., CHICAGO 7, ILL.

Circle 479 on Page 19

Helpful Literature

dielectric capacitors, and two different types of Mylar metallized capacitors are described in four engineering bulletins. Ratings, performance characteristics, and other data are presented. Astron Corp.

Circle 643 on Page 19

Fasteners

Shear and tension valves, holes size recommendations, and a sequence drawing illustrating the driving cycle of the CL Huckbolt fastener are contained in catalog 8-414. Pin tail end of fastener is broken off flush with locking collar during driving by hand or power-operated tool. Various fasteners are described, as are driving tools. 12 pages. Huck Mfg. Co.

Circle 644 on Page 19

Air-Cooled Engines

Descriptions and specifications of all models and variations of Kohler four-cycle, short-stroke, air-cooled engines are found in illustrated catalog "Kohler Engines in Action." Included are 3.6, 6.6, 12.5, and 24-hp models. Applications for each model are given. 28 pages. Kohler Co.

Circle 645 on Page 19

Brakes & Clutches

Easy-to-read facts about electric brakes, clutches, and controls for miniature mechanisms or high torque machine drives are given in Catalog WEB 6292. Specifications of available units are included. 8 pages. Warner Electric Brake & Clutch Co.

Circle 646 on Page 19

Custom-Machined Teflon

Facilities for custom-machining Teflon parts are detailed in illustrated folder. Typical components made to customers' specifications are shown This chemical resistant plastic has an almost frictionless surface and withstands temperatures to 500° F. Raybestos-Manhattan, Inc., Plastics Products Sales Div.

Circle 647 on Page 19

Metal Hose & Fittings

List prices on Mulconroy flexible All-Metal hose and couplings of steel and bronze are tabulated in Bulletin MH57. Brief descriptions are included on each type and size. 6 pages. Mulconroy Co.

Circle 648 on Page 19

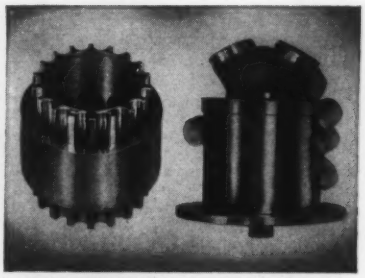
Lapped Metal Balls

Detailed specifications as well as helpful application and design data are presented in Bulletin 101 on chrome steel, stainless steel, brass, bronze, and Monel balls in various grades and sizes ranging in diameter from 1/16 to 4½ in. Also described are Micro-Velvet balls which are accurate within millionths of an inch. 8 pages. Hoover Ball & Bearing Co.

Circle 649 on Page 19

Machinery Lubricator

The Type AP-Lubricator provides two independent lubricating systems on a single machine, one system providing continuous-flow constant-pressure lubrication to certain bearings, and the other giving cyclic or periodical lubrication to other bearings. Design and performance data are



MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES

The American Laundry Machinery Co., Rochester, N. Y.
Atlas Foundry Co., Detroit, Mich.
Banner Iron Works, St. Louis, Mo.
Barnett Foundry & Machine Co., Irvington, N. J.
Blackmer Pump Co., Grand Rapids, Mich.
Centrifugally Cast Products Div., The Shenango Furnace Co., Dover, Ohio
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
Empire Pattern & Foundry Co., Tulsa, Okla. and Bonham, Texas
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machines Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
Greenlee Foundry Co., Chicago, Ill.
The Hamilton Foundry & Machine Co., Hamilton, Ohio
Hardinge Company, Inc., New York, N. Y.
Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Koehring Co., Milwaukee, Wis.
Lincoln Foundry Corp., Los Angeles, Calif.
Nordberg Manufacturing Co., Milwaukee, Wis. and St. Louis, Mo.
Palmyra Foundry Co., Inc., Palmyra, N. J.
The Henry Perkins Co., Bridgewater, Mass.
Pohlman Foundry Co., Inc., Buffalo, N. Y.
The Prescott Co., Menominee, Michigan
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Sonith Industries, Inc., Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Valley Iron Works, Inc., St. Paul, Minn.
Vulcan Foundry Co., Oakland, Calif.
Washington Iron Works, Seattle, Wash.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario

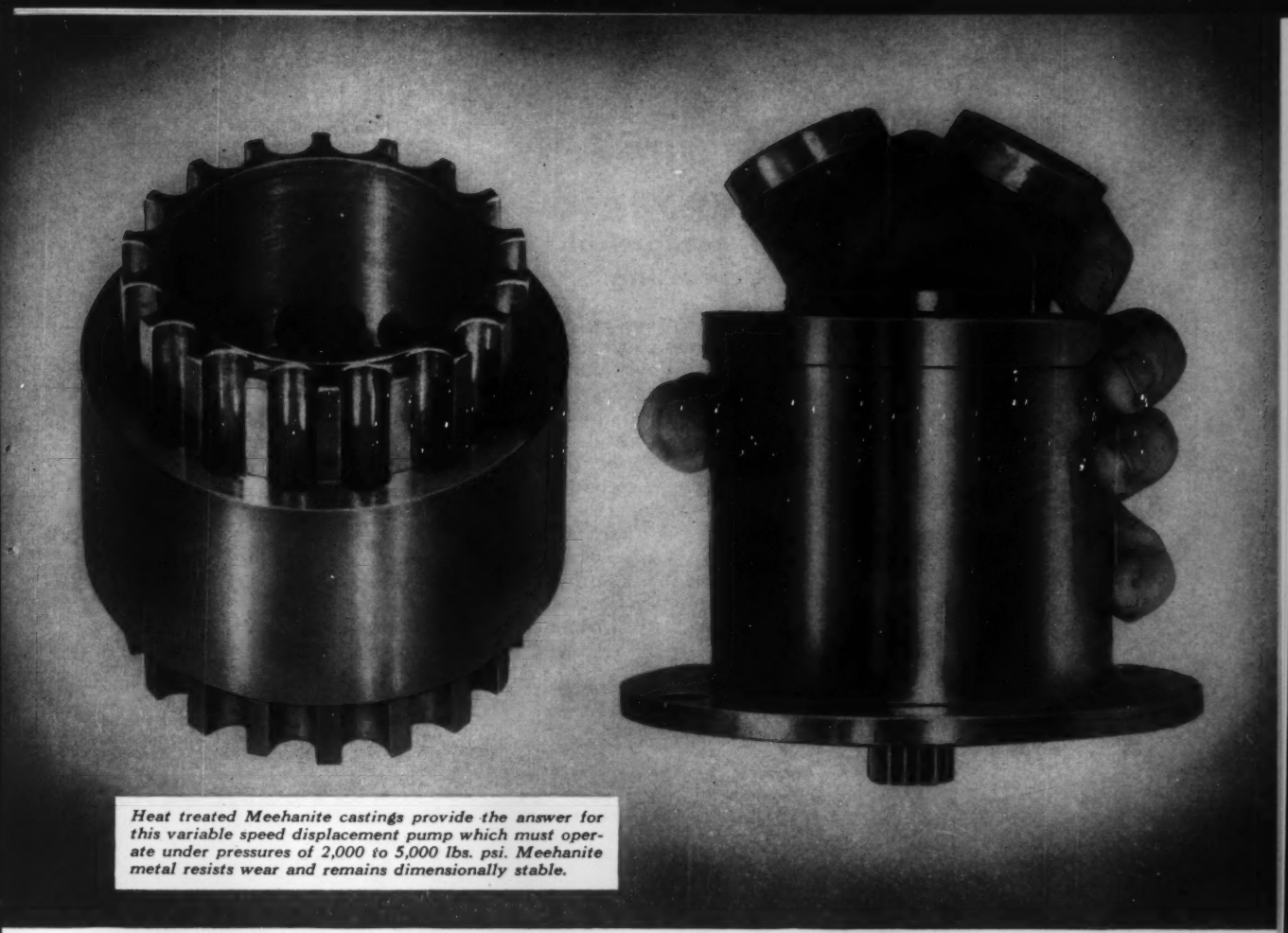
"Heat Treatment of Meehanite®"

Write for your free single copy today Technical Data Sheet No. 5.

Write today to Meehanite Metal Corporation, Department 4D, 714 North Avenue, New Rochelle, New York.

MEEHANITE®

Circle 480 on Page 19



Heat treated Meehanite castings provide the answer for this variable speed displacement pump which must operate under pressures of 2,000 to 5,000 lbs. psi. Meehanite metal resists wear and remains dimensionally stable.

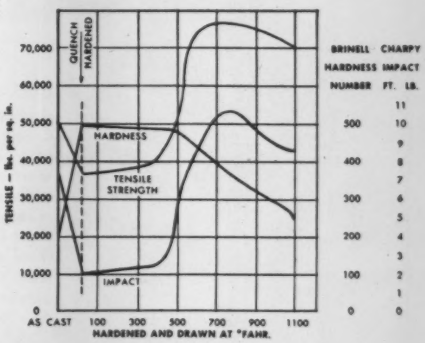
Heat treated Meehanite castings provide higher strength, toughness and increased resistance to wear

Because of its uniform structure, heat treated Meehanite® may be machined at higher Brinell hardness values and assures strong, tough, hard wearing castings able to withstand severe service conditions.

The main objectives in the heat treatment of Meehanite® are: to stress relieve complex castings by removing internal strains without changing physical properties; to improve machinability without loss of strength and hardness; and to obtain greater hardness, strength, toughness and wear resistance.

Heat treated Meehanite castings are finding wide applications in engineering components because of their superior strength characteristics, high damping capacity, pressure tightness, dimensional stability and uniformity.

If you would like more information about the heat treatment of Meehanite castings, consult a Meehanite foundry and write today for your copy of Technical Data Sheet No. 5.



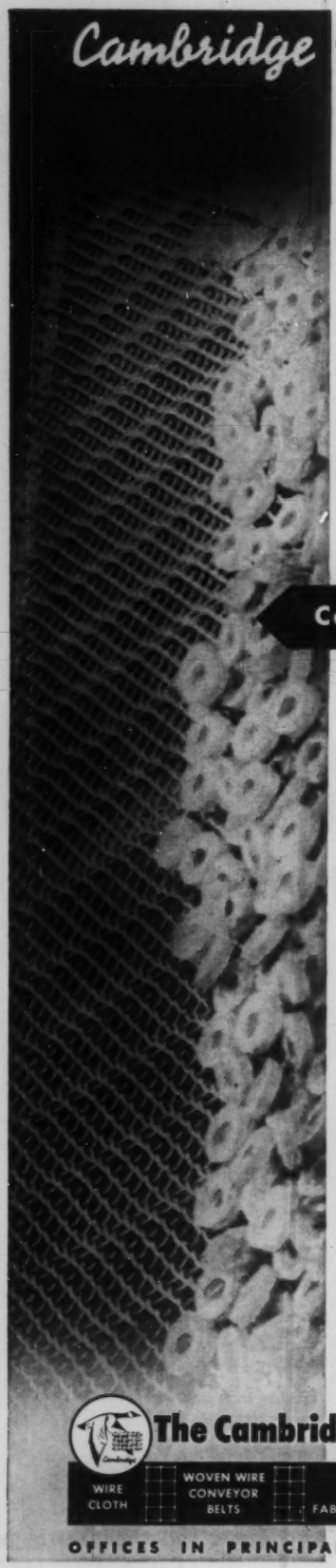
The effect of quench and draw treatment on the impact strength and hardness of type GA Meehanite is portrayed above.

MEEHANITE BRIDGES THE GAP BETWEEN CAST IRON AND STEEL®

MEEHANITE METAL

MEEHANITE METAL CORPORATION, NEW ROCHELLE, NEW YORK

Circle 480 on Page 19



Cambridge

Woven Wire Belts give you fast, economical processing

Using woven wire conveyor belts to move products through all phases of your manufacturing operation helps speed processing and cuts costly batch handling. Food products, chemicals, plastics, metal parts, ceramics or glass can be treated faster and easier with a continuous belt-to-belt flow through the plant on woven wire belts. Controlled belt speeds through any type of operation . . . hot or cold, wet or dry . . . help increase product uniformity and maintain capacity production. EXAMPLE:

Continuous Cooling

MOVING BELT carries hot candy through cooling tunnel in a steady stream. Free circulation of air through open mesh speeds cooling process.

ALL METAL BELT cannot absorb odors . . . remains unaffected by processing solutions, 2100°F. or sub-zero temperatures . . . gives longer life because there are no seams, lacers or fasteners to weaken or break. Rust-proof alloys maintain sanitary requirements.

OPEN MESH also provides free circulation of heat or cold, free drainage of process solutions. Broken bits or chips of the product fall through the open mesh to maintain product uniformity.

SPECIAL RAISED EDGES or surface attachments are available to hold products on belt during inclined travel.

Cambridge Woven Wire Conveyor Belts are a practical and economical means of combining movement with processing in any type of industry . . . food, chemical, metalworking, glass or ceramics . . . on all types of machines for your own operation or for resale. Cambridge Woven Wire Conveyor Belts are made in any size, mesh or weave, from any metal or alloy to do the job you want . . . hot or cold, wet or dry. Call your Cambridge Field Engineer to discuss how you can get fast, economical processing with woven wire conveyor belts. Look under "Belting, Mechanical" in the *Yellow Pages*. Or, write for FREE 130-PAGE REFERENCE MANUAL.

The Cambridge Wire Cloth Co.

Department N,
Cambridge 11,
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WIRE CLOTH | WOVEN WIRE CONVEYOR BELTS | WIRE CLOTH FABRICATIONS

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

Helpful Literature

given in technical reference Bulletin TR-57B. 2 pages. Bijur Lubricating Corp.

Circle 650 on Page 19

Electronic Tubes

General specifications, tube type, characteristics, ratings, and operating data on rectifiers, triodes, clipper diodes, and other electronic tubes for industrial and communications use are tabulated in Catalog 2210. Central Electronics Manufacturers, Inc.

Circle 651 on Page 19

Mica Specifications

Selection and estimation of mica needs for fabricated parts is provided by illustrated "Mica Selector." Part or full-size sketch is merely laid on chart to determine the material needed. Data are included on mica. 2 pages. Ford Radio & Mica Corp.

Circle 652 on Page 19

Polyethylene

Technical Bulletin C-5-225 contains complete properties, molding, and application guidance on Dylan polyethylene for injection molding. Typical products made with this general purpose molding material are shown. 16 pages. Koppers Co., Chemical Div.

Circle 653 on Page 19

Electrical Connectors

Design data, application information, and technical guidance for the selection and use of A-MP Faston connectors are given in Bulletin R-C-57. Terminals are applied to wires manually or automatically. Sizes and types are available for No. 12 to No. 24 wires. 8 pages. AMP Inc.

Circle 654 on Page 19

Tubular Material Data

Stress rupture data on B & W Croloys and other tubular materials for high-temperature service are tabulated in Technical Data Card 153-B. 4 pages. Babcock & Wilcox Co., Tubular Products Div.

Circle 655 on Page 19

Variable Speed Drives

Slide-rule type Thymotrol adjustable speed drive selector assists in selecting the proper motor, control panel, and operator's station for any fractional to 3 hp variable speed drive requirement. Designated GEN-169, this plastic calculator is easy to use. It is available free from General Electric Co.

Circle 656 on Page 19

Electronic Instruments

Wide-band direct current amplifiers, microvoltmeters, electronic galvanometer, direct current power supplies, meter calibrators, and direct current standard and null meter are described in illustrated Catalog 17-1. 4 pages. Cohu Electronics Inc., Kin Tel Div.

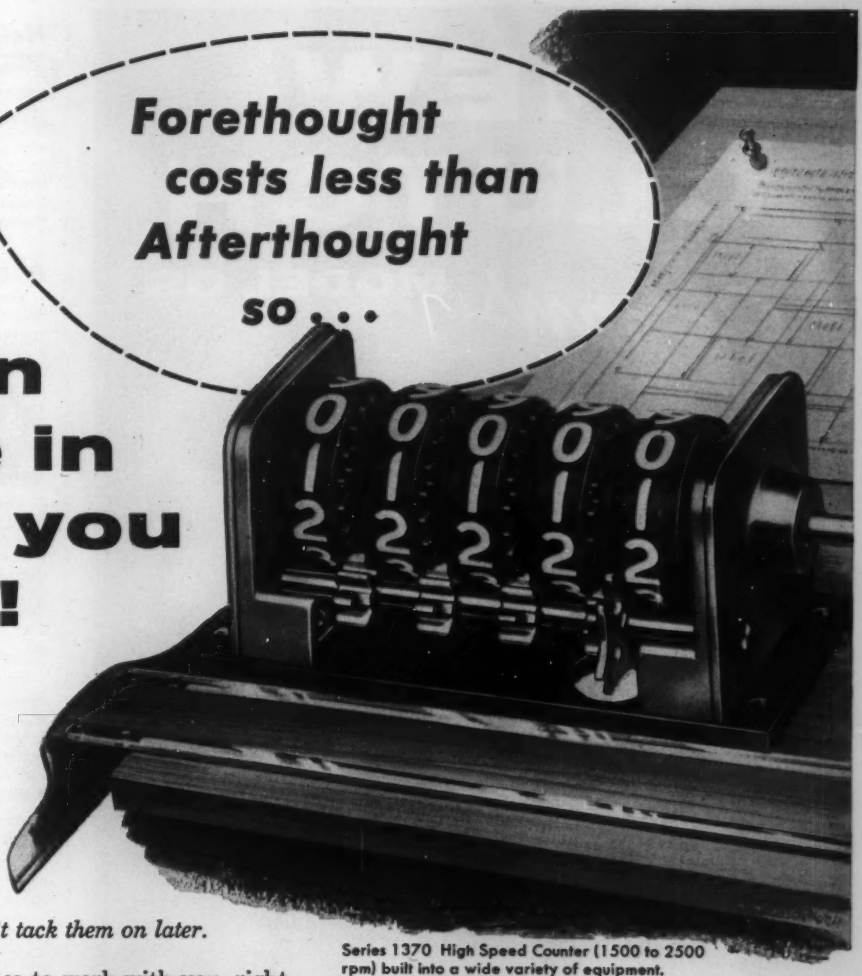
Circle 657 on Page 19

Machine Tool Controls

True-Trace continuous and intermittent positioning systems, hydraulic tracers, numerical controls and pro-

Forethought costs less than Afterthought so . . .

Design These in When you Begin!



If you need mechanical or electrical counters in any of your new products, here's a word to the cost-wise designer: *Design them in, when you begin . . . don't tack them on later.*

Series 1370 High Speed Counter (1500 to 2500 rpm) built into a wide variety of equipment.

For if you'll give us a chance to work with you, right from the beginning, chances are we can save you time and money by adapting or modifying a *standard* Veeder-Root Counter to your needs . . where you might get into a costly special job if you went about it alone. What's more, you save time in your engineering, purchasing and assembly departments.

Count on Veeder-Root to help you in every way . . . from design to delivery. Write:

Everyone... Can Count on Veeder-Root

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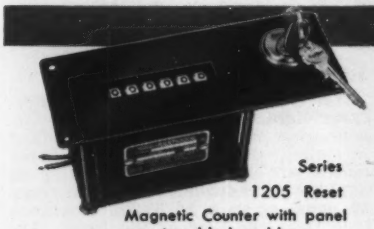
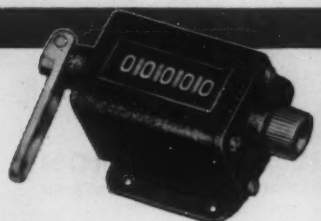
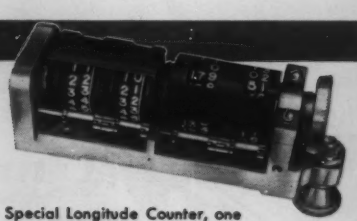


Series 1205 Reset Magnetic Counter with panel mount and lock and key.



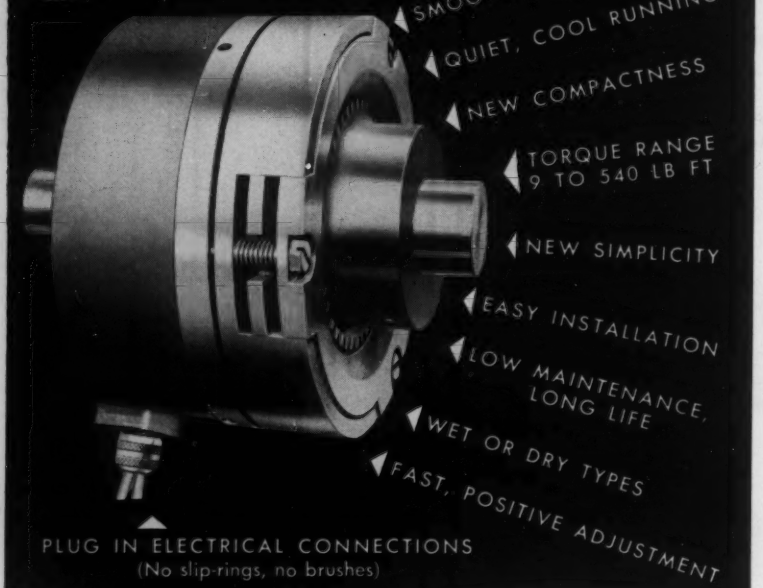
Series 1122 Small Reset Ratchet Counter.



Special Longitude Counter, one of many made for aircraft navigational equipment.

NEW CLUTCH

Stearns MODEL GS



Save — up to 41% on space
— up to 33% on installed cost

Here's a new concept in electro-magnetic clutches that add an even greater range of application to the already comprehensive Stearns line of over 100 standard clutch and clutch-brake combinations. Stearns can serve your needs on equipment ranging from business machines to ball mills — and larger . . . will also custom-design units to your specific requirements.

For complete data on the new "GS" line, call your local Stearns representative . . . or write for Bulletin 503F. 26

BRAKES MILWAUKEE Stearns WISCONSIN CLUTCHES

ELECTRIC CORPORATION
120 NORTH BROADWAY • MILWAUKEE 2, WISCONSIN

Helpful Literature

gramming consoles, and other machine tool controls are subject of illustrated bulletin. Also described are accessory units such as hydraulic cylinders, power units, hydraulic milling spindles, coolers, and mounting brackets. 24 pages. True-Trace Sales Corp.

Circle 658 on Page 19

Brake Block Sets

Industrial applications of Red Block brake sets are subject of illustrated Bulletin 101-A. Described are sizes, shapes, and thicknesses to meet every braking need on such equipment as presses, cranes, oil well rigs, and construction equipment. 4 pages. World Bestos.

Circle 659 on Page 19

Rolling Mill Couplings

Design features and application data on various sizes and types of Ajax Dihedral spindle couplings for rolling mill drives are covered in Catalog 64. Bore diameters range to 12 in. 12 pages. Ajax Flexible Coupling Co.

Circle 660 on Page 19

Sheet Packing

Complete data on a line of 19 different sheet packings, together with service recommendations, are contained in Bulletin P-328. Included is information on chemically inert Teflon sheet for −120 to 500° F service. 8 pages. Crane Packing Co.

Circle 661 on Page 19

Ways & Gibs

O.K. hardened ways and gibs, composite die sections, heel and guide blocks, die wear plates, clad bronze wear plates and ways, and Bronzoil oil-impregnated powdered bronze bearing materials are described in illustrated catalog. 16 pages. Ohio Knife Co.

Circle 662 on Page 19

Speed Reducers

Some 164 standard styles and sizes of double-reduction speed reducers with ratios ranging from 75:1 to 4900:1 are detailed in illustrated Catalog CD-230. Reducers are available in worm over, worm under, or gear shaft vertical models with output ratings up to 618,000 lb-in. 20 pages. Michigan Tool Co., Cone-Drive Gears Div.

Circle 663 on Page 19

Packaged Electronic Circuits

Schematics and specifications of 96 P.E.C. (packaged electronic circuits) used by 130 radio and television manufacturers since 1949 are presented in Guide No. 4. Globe-Union Inc., Centralab Div.

Circle 664 on Page 19

Subminiature Indicator Lights

Newly designed subminiature indicator lights which use the tiny GE neon glow lamp NE-2D are described in Bulletin L-159. Units, with dome lenses, are available for mounting in a 17/32 in. clearance hole from front of panel or in a 15/32 in. clearance hole from the rear of the panel. Average life is 25,000 hr. Dialight Corp.

Circle 665 on Page 19

Circle 483 on Page 19

Circle 484 on Page 19→

DOW CORNING CORPORATION

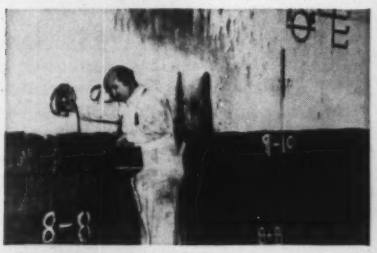
Silicone News

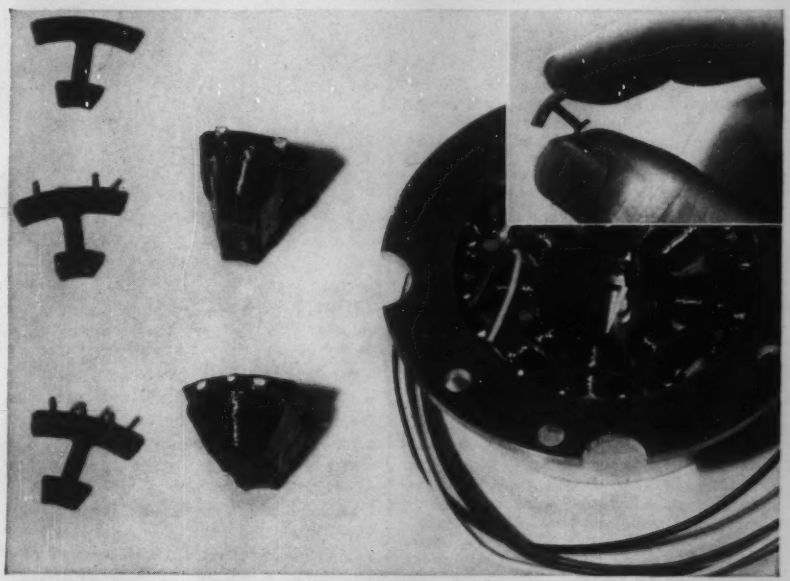
FOR DESIGN ENGINEERS No. 44

New Ultra-sonic Measuring Device Employs Silicone-glass Laminates

Problem: How to measure thickness of something like a tank car or tanker's hull? Old way — cut a hole, gauge and patch. New way — use ultra-sonic thickness-measuring equipment developed by Branson Instruments, Inc., of Stamford, Conn. The new method permits quick and accurate determination of the thickness of metal, glass or plastic without costly shutdowns. Here's how:

Branson's ingenious measuring device uses a transducer consisting of a slice of quartz cemented to silicone-glass laminate with an epoxy adhesive. The transducer is wired and powered to generate 0.65 to 6.0 Mc. When placed against the side of the material to be measured, it transmits a narrow-beam wave reflected by the (Cont. Pg. 2)





SILICONE DIELECTRICS AID MINIATURIZATION

Silicone dielectrics help designers reduce the size and weight of miniature motors while increasing their dependability. Case in point: the new Servo motors produced by the Aeronautical Division of Minneapolis-Honeywell.

Containing what is believed to be the smallest stator coils ever wound for an ac motor, this entire motor is no larger than a golf ball. It weighs a mere 2 ounces, operates at controlled speeds ranging from zero to 11,000 rpm and develops a stall-torque of 0.75 ounce-inches.

Despite their miniature size, the motors withstand operational temperatures of 500 F and higher because they are fully insulated with heat-stable Dow Corning Silicones. Wound on bobbins, the tiny stator coils are held in place and insulated from the frame by terminal supports molded from Dow Corning 301 Molding Compound to assure adequate mechanical strength.

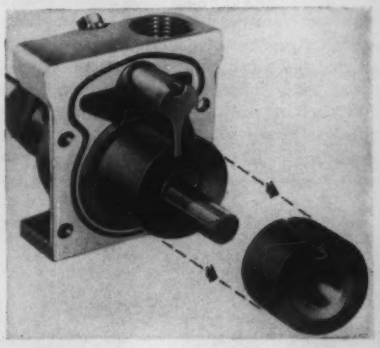
The miniature Servo motors drive calibrators, synchros, indicators and other assemblies for Honeywell's fuel measurement, automatic flight control and other aircraft instrument and engine control systems.

They present a "Tom Thumb" illustration of the adage, "Dow Corning Silicones give motors more muscles . . . more power per pound." *No. 446*

SILICONE FLUID PROTECTS RUBBER PARTS IN STORAGE

Not all products are put to immediate use. That's why limited "shelf life" of a single component can seriously affect product performance and customer satisfaction. Faced with such a problem Eco Engineering Co., Newark, N. J. utilizes Dow Corning 200 Fluid to safeguard the performance of positive displacement rotary pumps during long periods of storage.

Eco pumps are sometimes stored for years before being put into service, or assigned standby duty under humid or freezing conditions. To prevent the rubber impellers from swelling during storage, and "freezing" to the casing, Eco used to apply water-soluble greases and oils to these parts. These organic lubricants, however, had to be flushed away with water before the pumps could be used. What's more, if left in storage too long, the greases decomposed and attacked the rubber parts, causing the impellers to swell and rendering the pumps useless. (Cont. Pg. 2)



FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

NEW LITERATURE AND TECHNICAL DATA ON SILICONES

Dow Corning Silicone Compounds, for dielectric applications, for release of plastic and rubber moldings, and for protecting finely machined thread parts, are described and compared in a handy reference pamphlet. *No. 450*

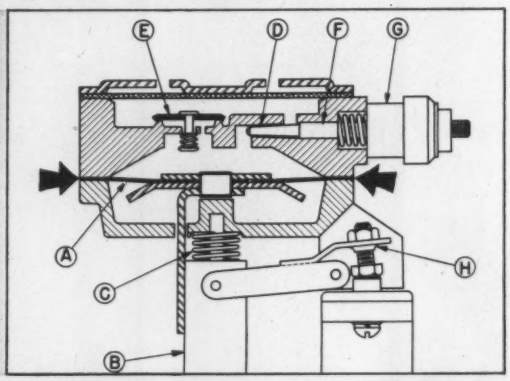
Antifoam B, the lowest priced silicone foam-killer, has greater stability than any other water dilutable silicone defoamer commercially available. Antifoam B will not separate, oil out, settle or precipitate in most applications; retains uniformity and effectiveness even under adverse storage or operating conditions. Ready to use, it requires no diluting or pre-mixing. *No. 451*

Parts and components made with Dow Corning Silicone Molding Compounds are lightweight, show excellent resistance to heat, and have good structural and electrical properties. Used as brush holders, collector rings, terminal boards, multiple lead connectors, heat dams for turbine driven alternator bearings, and aircraft brake shoe backing. *No. 452*

Silicone Rubber That Vulcanizes At Room Temperature — that's new SILASTIC RTV 501. Has good shelf life before catalyzing, longer working time after catalyzing. Two fluid components, mixed together, vulcanize over a period of 24 hours to form a 30 durometer rubber serviceable from —70 to 500 F. *No. 453*

Pressure-sensitive silicone tapes — that stick to wet or dry surfaces; form good bonds; have high dielectric strength; repel moisture; are not affected by corrosive chemicals—are described in a new folder designed to help you choose the tape best suited to your application. *No. 454*

New Silicone Coating for paper and paperboard keeps gummy and tacky materials from sticking to all types of bags, boxes, inner liners, wraps and interleaving sheets. Will not migrate; will not contaminate materials that come in contact with it. New brochure containing sample papers describes how Silicone Coating aids packagers and processors of sticky products. *No. 455*



SQUARE D EMPLOYS SILASTIC TO ASSURE TIMER ACCURACY

Proof that Dow Corning Silicones improve product design and performance without throwing costs out of balance is their growing use in high-volume production items. An example of this trend is found at Square D Company where designers use Silastic*, the Dow Corning silicone rubber, to assure dependable performance of sensitive diaphragms in their pneumatic timing relays.

Since the diaphragms producing the time delay must depend upon a light spring for movement, even a slight change in flexibility of the rubber would adversely affect timing accuracy. With diaphragms made of heat and cold resistant Silastic, the timers give accurate, controlled delays ranging in duration from .05 seconds to 3 minutes over a wide temperature span.

Square D pneumatic timers are used primarily on ac and dc reduced voltage motor starters and on machine tool and spot welding controls. They may also be employed in groups. For example, in spot welding with air or hydraulic welding machines a series of relays automatically times the squeeze, weld, heat, cool, hold and shut off operations in sequence. *No. 447*

*T. M. REG. U. S. PAT. OFF.

SILICONE-GLASS LAMINATES *(Cont.)*

other side. The frequency of this signal is adjusted until the transmitted and reflected waves are in phase. With this frequency as a starting point, the operator accurately calculates the thicknes of the material. The device is ideal for measuring the thickness of pressure vessels, piping, ship hulls and forgings.

Glass laminate bonded with Dow Corning silicone resin was selected for the transducer mount because it withstands the high curing temperature of the epoxy adhesive and makes it possible to use the unit on surfaces as hot as 450 F. Another plus: silicone-glass laminate is also an excellent absorber of ultra-sonic energy. *No. 448*

SILICONE FLUID *(Cont.)*

Eco Engineering solved these problems by changing to semi-inorganic Dow Corning 200 Fluid. Non-reacting with organic rubber, 200 Fluid prolongs the life of the rubber impellers. Furthermore, since the silicone fluid can be left in the unit, the pumps are always ready for instant use.

Easily applied, the protective silicone fluid is simply sprayed into the pump ports with an atomizer developing 80 psi; the operator slowly rotates the impeller by hand during the 15 second application. To date, more than 50,000 silicone-protected pumps have been delivered without a single customer complaint. *No. 449*

Dow Corning Corporation, Dept. 6823, Midland, Michigan

Please send me: 446 447 448 449 450 451 452 453 454 455

NAME _____

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SILICONE NEWS is published for product design and development engineers by

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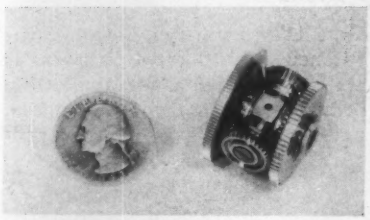
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Hollow-Shaft Differential

operates at speeds to 2500 rpm

Double-pinion, hollow-shaft differential features increased torque capacity. It operates at speeds to 2500 rpm, with up to 32 oz-in. torque input. AGMA Precision Class II gearing is used throughout. Backlash at no load is under 1 min, with starting and running friction torques



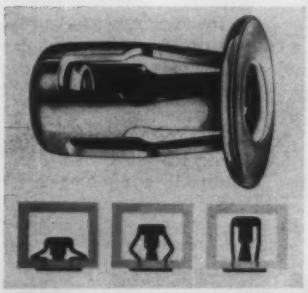
held to extremely low values. Hollow-shaft design accommodates ⅛ and 3/16-in. shafting and permits permanent or temporary pinning to an existing shaft. Completely interchangeable end gears are available in wide tooth ranges for 48, 64, 96, and 120 diametral pitch. **Reeves Instrument Corp.**, 207 E. 91st St., New York 28, N. Y.

Circle 666 on Page 19

Blind Fastener

grips any material from 0 to ⅜ in. thick

Jack Nut threaded blind fastener grips any material from 0 to ⅜ in. thick. It is self-adjusting to grip evenly on rough and curved as well as smooth and level surfaces. Units can be used as rivets and/or blind fasteners in expansion space as small as ⅜ in. They provide firm nutplates for attachment screws and anchorage is permanent, permitting screws to be removed and replaced. Fasteners



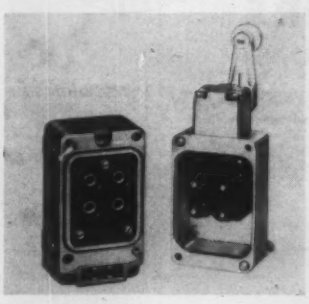
make a vibrationproof assembly, with weight-carrying capacity limited in most cases only by the strength of the material in which they are used. Holes can be fashioned before, during, or after fabrication. Units are available in short lengths for thicknesses from 0 to 3/16., and long lengths for 0 to 3/8. They are installed with a screwdriver and any 6-32, 10-24, or ¼-20 screw. **Molly Corp.**, 230 N. Fifth St., Reading, Pa.

Circle 667 on Page 19

Limit Switch

two-part unit is plugged together

Plug-in precision limit switch, designated 201LS1, consists of a terminal block enclosure, containing wiring connections, and a switch enclosure, including all moving mechanical and electrical parts. Switch



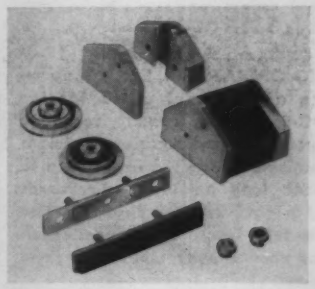
enclosure has four current-carrying spring plugs, integrally molded to basic switching element, and terminal block has four corresponding receptacles. When plugged together, they form a complete switching unit. Unit can be replaced easily by pulling off the switch and plugging on the replacement unit. **Micro Switch**, Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle 668 on Page 19

Bonded Parts

are of rubber-to-metal

Rubber-to-metal bonded assemblies are available in solid, sponge, natural, and synthetic rubber. Ferrous and nonferrous inserts are prepared and sandblasted before



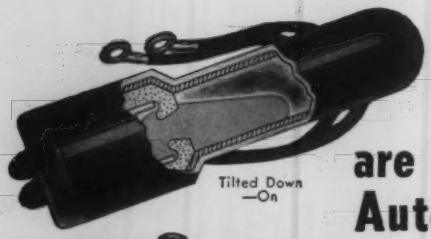
molding. Shown is a group of typical bonded parts. **Mechanical Rubber Products Co.**, 35 Vail Rd., Warwick, N. Y.

Circle 669 on Page 19

Level Control

detects liquid, solid, and slurry levels

Model CL-10 Dynatrol level control provides accurate high or low-point detection, or narrow-range proportional control of liquid, solid, and slurry levels. Control has



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Circle 485 on Page 19

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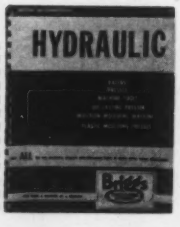
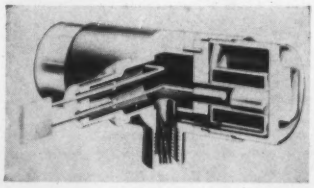


New Parts



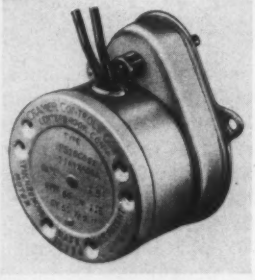
a positive-acting electrical output control signal that varies with the amount of immersion of the 120-cps vibrating paddle in the medium being detected. Output signal can control the operation of any type of electrical equipment. Vibrationproof, corrosion - resistant unit is rated for 3000 psig pressure. **Automation Products Inc.**, 3030 Max Roy St., Houston 24, Tex.

Circle 670 on Page 19

Miniature AC Motor

has speeds from 2 to 72 rmp

Type 117H permanent-magnet synchronous motor, rated 60 oz-in. at 1 rpm, is designed for application in high-speed controllers, counters, and metering devices. It is avail-



able in speeds from 2 to 72 rpm. Unit has low input, small size, and maximum temperature rise of 35 C. It provides instant stop due to low rotor speed and magnetic braking effect. Capable of operating in any position, motor is available for either left or right-hand rotation in all speeds. **Cramer Controls Corp.**, Centerbrook, Conn.

Circle 671 on Page 19

Mounting Receptacles

for applications with light loads

Two new receptacles are for side and corner mounting of quick-operating fasteners to meet automa-

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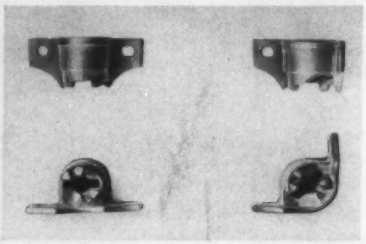
tion requirements. Designed for applications with light loads, they are die cast of aluminum alloy and meet MIL-A-8625. Mounting holes have relaxed mounting tolerance to permit a low-cost production operation. Receptacles eliminate the



need for a mounting flange and permit maximum accessibility to working areas. **Camloc Fastener Corp.**, 22 Spring Valley Rd., Paramus, N. J.

Circle 672 on Page 19

Mirror-Finish Wire

has corrosion-resistant surface

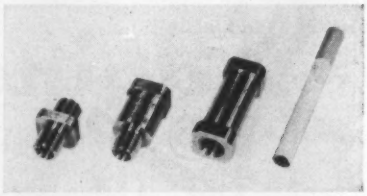
New mirror-finish wire is available flat and in shapes of Monel, nickel, Inconel, Inconel X, Incoloy, Ni-O-Nel, nickel-clad copper, Ni-Span C, and Techalloy stainless steels. Advantages include ease of forming, and greater freedom from corrosion. **Techalloy Co. Inc.**, Rahns, Pa.

Circle 673 on Page 19

Pressure Snubbers

miniature units are for high-pressure fluid systems

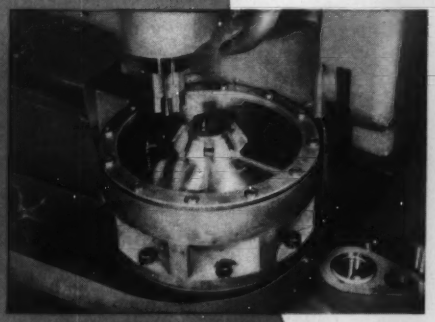
New pressure snubbers are designed for high-pressure fluid systems in advanced aircraft and missiles, as well as in ground installations. They damp out high-pres-



sure surges and pump ripples, allowing smooth pressure increase. Snubbers are as small as 11/16 x 1 1/16 in., and have typical weight

Circle 488 on Page 19

How Gear Shaper *Versatility* helps IMPROVE DESIGN

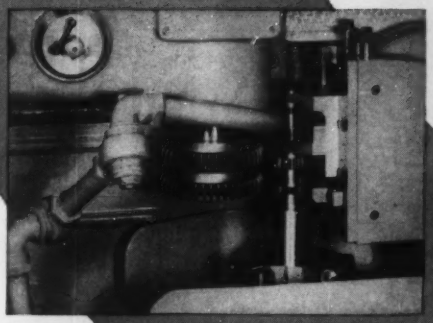


Quick-acting, air-operated diaphragm chuck speeds loading and unloading of pump rotor on Fellows No. 7A-Type Gear Shaper.

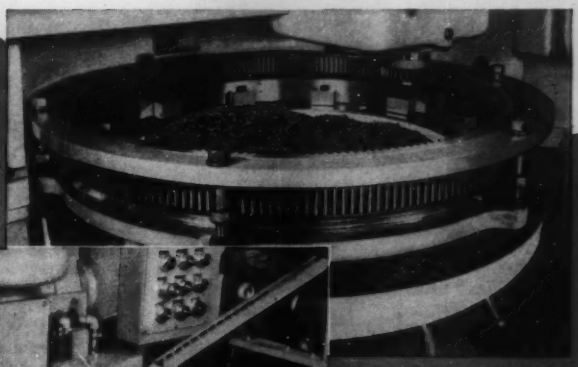
The Gear Shaper principle of generating with a reciprocating tool provides a versatile and economical method of manufacture which allows the engineer much greater latitude in the design of parts for low cost production. Special fixtures and controls permit cutting gears, intricate contours and other shapes in tandem or combination where otherwise, special-purpose machines might be required.

Free booklet — "The Art of Generating with a Reciprocating Tool" — shows in engineering detail how you can use Fellows Gear Shaper versatility to simplify and improve design. Write for it now.

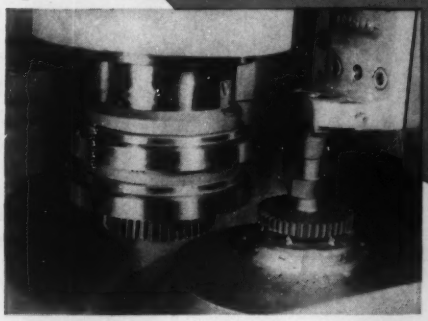
THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont
Branch Offices: 1048 N. Woodward Ave., Royal Oak, Mich.
5835 W. North Ave., Chicago 39
150 W. Pleasant Ave., Maywood, N. J.
6214 W. Manchester Ave., Los Angeles 45



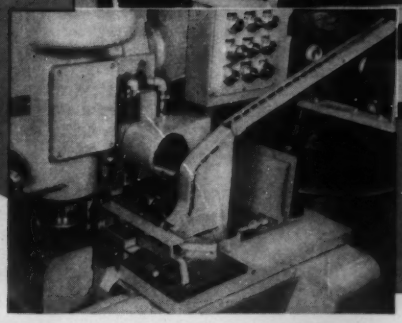
Two Gear Shaper Cutters in tandem cut automotive gears simultaneously. Center support fixture holds part in No. 4GS Gear Shaper.



Special fixture holds combination internal-external gear while internal gear is cut on 33-Type Gear Shaper.



Two cams and one gear are cut simultaneously on a gasoline motor part. Center support fixture holds part in No. 4GS Gear Shaper.



Fixture for automatically loading and unloading automotive pinions on the No. 4GS Gear Shaper.

THE PRECISION LINE **Fellows** *Gear Production Equipment*

A

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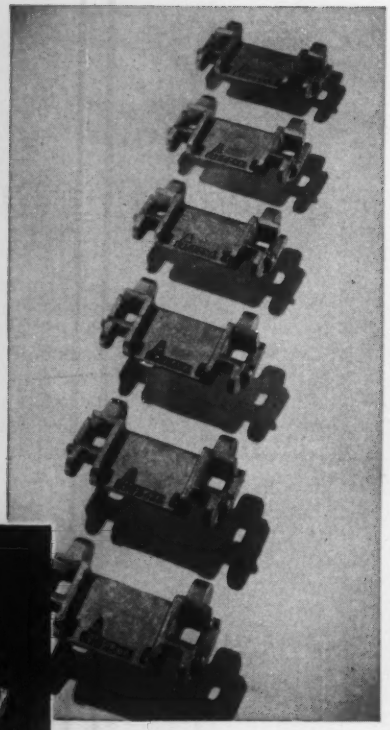
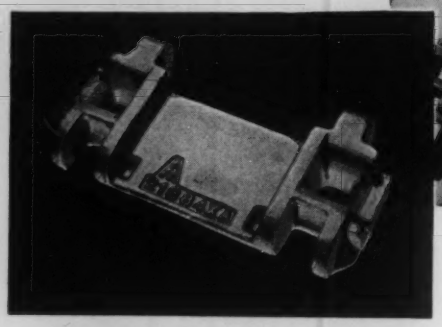
"STEPS"

IN THE

RIGHT

DIRECTION . .





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Unitcast

SPECIFICATION STEEL CASTINGS

New Parts

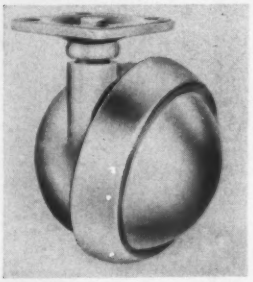
of 0.037 lb for ¼-in. line size. The stainless-steel units can be used with hydraulic fluids, missile fuels and oxidizers, lubricating and engine oils, alcohol, water, and all other fluids compatible with Series 300 stainless steels. Snubbers are for systems with operating pressures to 4000 psi and operate under temperatures from −65 to 400 F. **A. U. Stone & Co. Inc.**, 23 W. 60th St., New York 23, N. Y.

Circle 674 on Page 19

Caster

operates on inclined-axle principle

New caster, suitable for furniture, office equipment, and industrial equipment applications, operates on an inclined-axle principle which forces instantaneous swiveling action at a light touch. Working parts of the caster are totally enclosed, and are lifetime lubricated. Rubber-tired wheels, with diameters of 2½ and 3½ in., are capable of supporting 75 to 100 lb per caster. Antique copper, satin chrome, bright chrome, satin brass, and bright brass finishes are offered. **Sierra Engineering Co.**, 123 E. Montecito Ave., Sierra Madre, Calif.



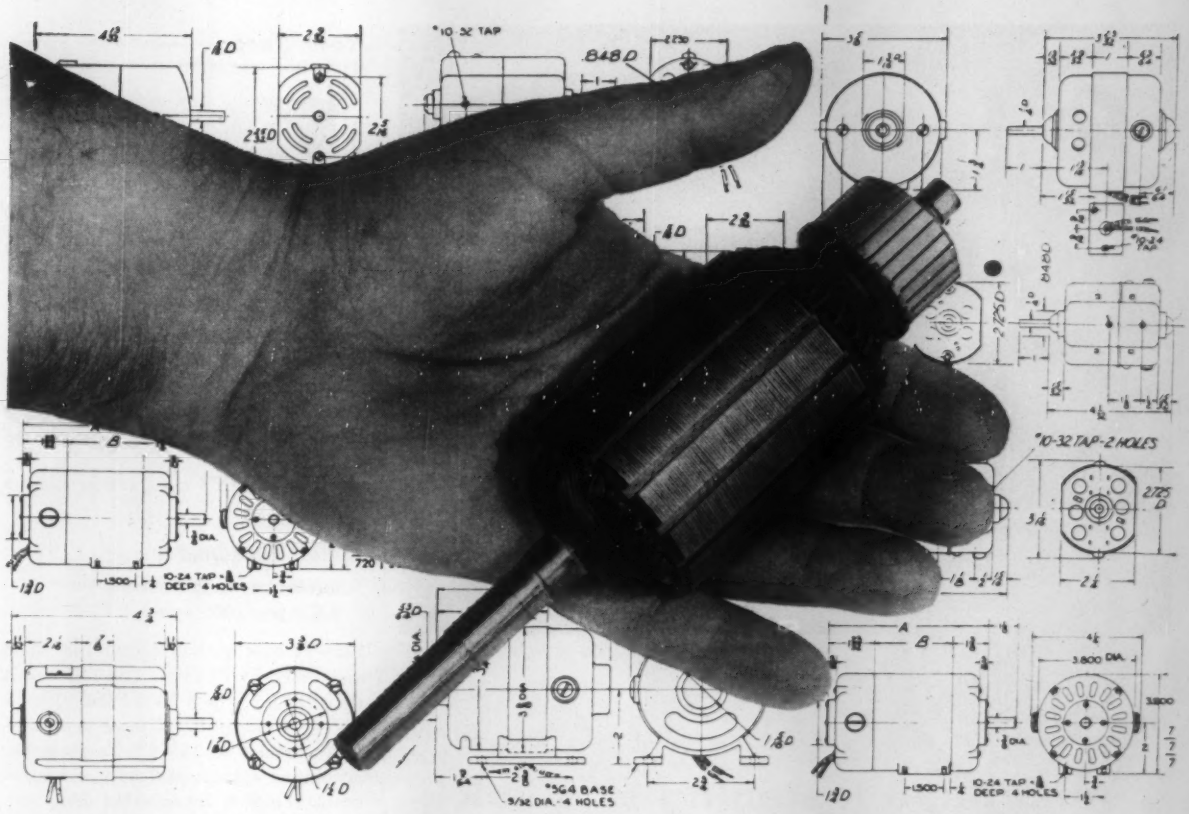
Circle 675 on Page 19

Electrolytic Capacitors

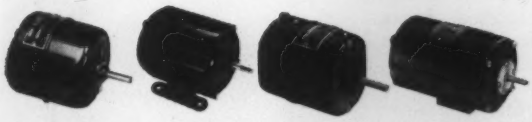
miniature aluminum units are rated at 4 to 150 v dc

Miniature aluminum electrolytic capacitors have only a few microamperes of electrical leakage. Ratings range from 1 to 125 mf and 4 to 150 v dc. Operating temperature range is − 20 to 85 C. Lengths range from ⅝ to 1¼ in. and diameters from 3/16 to 5/16 in. Centered axial leads permit

Circle 490 on Page 19



No "Shorts" or "Opens" in these Zanderoll Processed Howard Universal and D.C. Fractional H.P. Motors



One of many advanced production methods at Howard, the Zanderoll process provides armatures with deep, uniform varnish penetration for high bond strength and rock hard coils, thus reducing to an absolute minimum, "flying shorts" and "opens".

Here's how the Zanderoll process works to insure steady performance in Howard motors: Tightly wound armatures are automatically rotated through a series of two varnish dips and two baking ovens—mounted so that only the coils and laminations are varnished. The first varnish coat is thoroughly baked before application of the second, insuring a deep, even bond. This enables an armature to be mounted to close tolerances with the field.

Howard modern production methods include automatic slot cell insertion, which practically eliminates "grounds"; improved brush-holder construction for accurate alignment and longer life; 2-stage, 3-plane dynamic balancing; and automatic high tension winding for tough compact coils.

Check with Howard today if your current projects require Universal, D.C. or Induction fractional H.P. motors. With over 85,000 specs on file Howard is well equipped to provide the motor that best meets your application.

Other Howard motors: UNIVERSAL & D.C. 1/200 to 1/2 h.p. • SHADED POLE 1/2000 to 1/8 h.p. INDUCTION 1/1400 to 1/8 h.p. • SERVO MOTORS • GEAR MOTORS • BLOWERS

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Automatic fastening is quick and economical with Townsend tubular rivets

You reduce material and unit costs, get quick, secure fastening of metals, plastics and fabrics with Townsend tubular rivets. Any degree of automation is possible, for these rivets feed smoothly in all makes of machines—they have the uniform physical properties and accurate dimensions essential to precise operations.

Townsend tubular rivets generally have a lower installed cost than any fastener—also the slight pressure required to set them prevents damage to soft or fragile material. When properly clinched they have great holding power—develop shear strengths comparable to bulkier, more expensive fasteners.

Tubular rivets are light in weight—present an attractive appearance—add decorative appeal to many products. Townsend supplies these rivets in steel, brass, copper, aluminum, nickel-silver, and other special materials.

Quick delivery is assured by large stocks maintained in New Brighton, Pa.; Chicago; Santa Ana, Cal.; and Gananoque, Ontario. For information on how to increase fastening efficiency, write for Bulletin TL-103 to Townsend Company, P.O. Box 237-E, New Brighton, Pa.

The Fastening Authority

Townsend

COMPANY • ESTABLISHED 1816

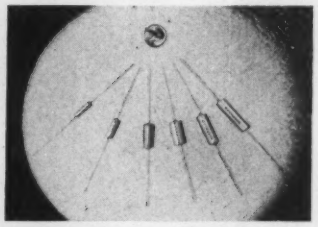
NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division • Santa Ana, California

In Canada: *Parmenter & Bulloch Manufacturing Company, Ltd., Gananoque, Ontario*

New Parts



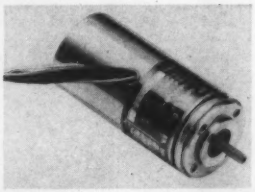
automatic insertion in printed-circuit boards. Case is electrically insulated and effectively sealed with epoxy-casting resin. **Magnavox Co.**, Bueter Rd., Ft. Wayne 4, Ind.

Circle 676 on Page 19

Motor Tachometer

miniature unit delivers 0.6 v per 1000 rpm

Size 11 motor tachometer has been shortened to 2.125 in. The 115-v unit delivers 0.6 v per 1000 rpm with 19 mv of total null. Upper temperature rating is 150 C. Tachometer combines a high-performance servomotor and a low-inertia drag cup damping tachometer-generator. It is available in many variations, including voltage and power ratings for transistor operation, special



lead locations, the incorporation of precision gearheads which facilitate the mechanical design of servo systems, and adaptation to unusual environmental requirements. Unit meets BuOrd Mark 14 specifications. **Eastern Air Devices Inc.**, 385 Central Ave., Dover, N. H.

Circle 677 on Page 19

Flow Meter

measures low float rates

MB Series Tapor-Flo meter is an all-glass, variable-area flow indicator designed for use in research laboratories, pilot plants, and bench-scale operations. It measures low flow rates with excellent stability. Float rises or falls in a precision-bore glass tube, pro-

KLIXON THERMOSTAT HELPS NEW EASY

Combination Washer-Dryer win dealer, public acceptance

With the new Easy combination washer-dryer a housewife just pushes a button and her clothes are "delivered" just the way she orders . . . washed, rinsed, dried . . . ready to iron or put away.

And, with the new Easy washer-dryer, accurate temperature control and service-free operation are insured through the use of Klixon Snap Acting thermostats.

R. C. Lamkin, Easy product engineer, is enthusiastic about the dependability of Klixon snap action thermostats. Here's what he says:

"Unquestionably, the outstanding performance of Klixon thermostats has contributed appreciably to the spirited acceptance of Easy's new combination Washer-Dryer by distributors, dealers, and users alike."

Klixon thermostats are available in many hermetically sealed and open types in a wide variety of operating temperature ranges.

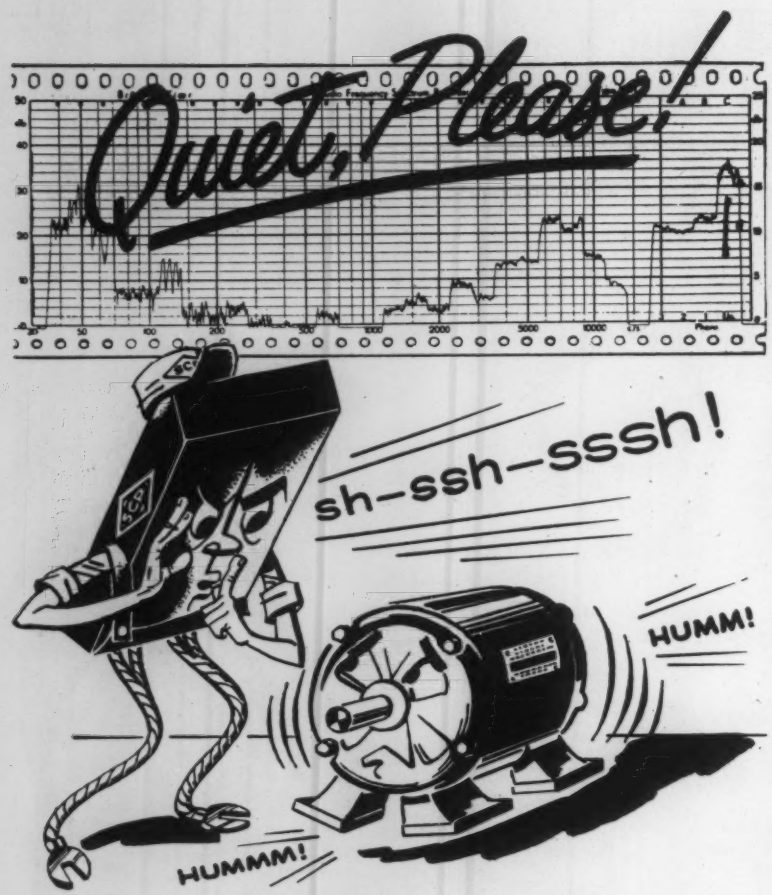
You, too, can benefit from using Klixon temperature controls. Get full details on how Klixon engineers, specialists in temperature control application can help you. Write today for thermostat catalog THSN.

Typical KLIXON Snap-Acting Thermostats used in many applications, including examples of the new 202 series for home appliances

METALS & CONTROLS CORPORATION

Spencer Thermostat Division 3211 Forest Street, Attleboro, Mass.

KLIXON®



LOW NOISE LEVEL BRUSHES BY SUPERIOR

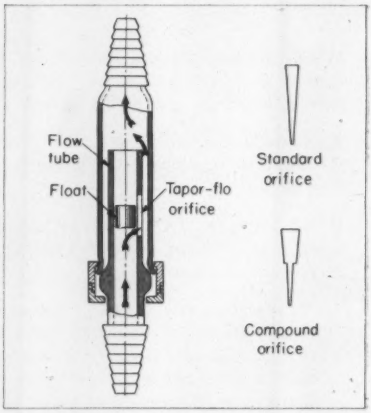
More and more, Industry is calling upon a Superior willingness to study a specific situation and come up with an answer that will make possible optimum brush performance.
More and more, Superior Carbon Brushes are doing a real job where noise level is an important factor.
More and more, a specialized Superior 37-year background is finding satisfactory solutions to these problems.
May we design a low noise level brush to meet your exacting requirements?

SUPERIOR
CARBON PRODUCTS, INC.
9115 GEORGE AVENUE, CLEVELAND 5, OHIO

SCP
SUPERIOR CARBON BRUSHES
"Since 1919"

New Parts

portionately exposing more or less of a V-shaped orifice. Float height is always directly proportional to flow rate. Flow value is indicated on an evenly graduated scale etched into the side of the flow tube. Meter is available with serrated glass connections, standard-taper ground-glass joints, ball joints, or standard Corning glass flanges. Standard flow-tube sizes are ¼ or ½ in. ID. Maximum operating pressure is 80 psi at 70 F, and maximum operating temperature is 150 F. A compound orifice is available to provide high-low range measurement. **C-Mar Corp.,** 35 Euclid Ave., Manasquan, N. J.



Circle 678 on Page 19

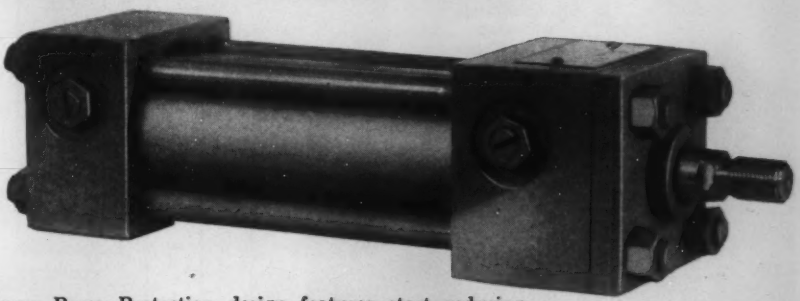
Synthetic Material

contains liquid as it is manufactured

Porelon consists of microscopic spheres of resin, dispersed in a mixture of a bonding agent and a liquid. Heat is applied, and bonding agent is absorbed into spheres. As spheres are fused together, liquid is trapped in the pores and held by capillary attraction. Liquid can then be given off at a predetermined rate by controlling pore size and viscosity of liquid. Material is manufactured in any color, molded to any shape, with any degree of resiliency. It can be produced without a liquid ingredient for use as sheeting, so that it becomes a waterproof material that permits free passage of air. Typical applications include use as a self-lubricating bushing or washer or installation in deli-

Can't be improved on?

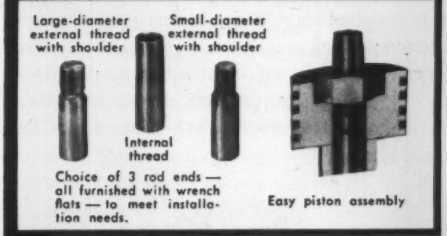
NEW POWER-PROTECTION DESIGN OF SERIES "N" CYLINDERS CUTS DOWNTIME LOSSES 11 WAYS!



Hydro-Line's new Power-Protection design features start reducing downtime losses even before the cylinders go to work — major assembly simplifications cut initial installation time *and* materially shorten every maintenance shutdown for the life of the cylinders.

Bores 1½ in. to 12 in. . . .
13 standard mounts . . .
2000-psi and higher operation

Series "N" rod bearing gives needed extra support



Choice of 3 rod ends — all furnished with wrench flats — to meet installation needs.

Easy piston assembly

4 WAYS THAT SERIES "N" PROTECTS YOU FROM SHUTDOWNS — Synthetic rubber wiper and seal (with nonextrusion washer) shown at left, have important design features producing two-way self-lubrication of the rod bearing without oil leakage: The *flared lip* of the seal is held against rod without mechanical pressure to permit a small amount of oil to cling to the rod for lubrication. The *precision-machined inner edge* of the wiper removes *all* oil from the rod on the outstroke, forms an almost perfect barrier against dirt and air on the instroke. The ground, hard-chrome-plated and polished piston rod resists abrasion and corrosion. Compare the long bronze rod bearing featured on Series "N" cylinders with conventional bearings like "A" with its useful length reduced by cavity for 3-piece rod wiper assembly and space needed for hat packing or bearing "B" that has seal very close to rod wiper reducing bearing strength at critical outboard end.

7 WAYS *POWER-PROTECTION* DESIGN SHORTENS ASSEMBLY AND MAINTENANCE TIME Hydro-Line's design requires fewer special tools and fewer replacement parts than any other. The piston, which is piloted to the rod, is attached or removed simply by turning a *self-locking hex nut.* A choice of *13 standard mountings,* available for every bore size from 1½" to 12", virtually eliminates custom installations. You also get *a choice of 3 rod ends . . . two, four or six wrench flats . . . extra-long rod bearing* to eliminate "jigsaw puzzle" assembly . . . *standard size "O" rings* for all static seals . . . and *interchangeable ball-check and needle-valve assemblies.*

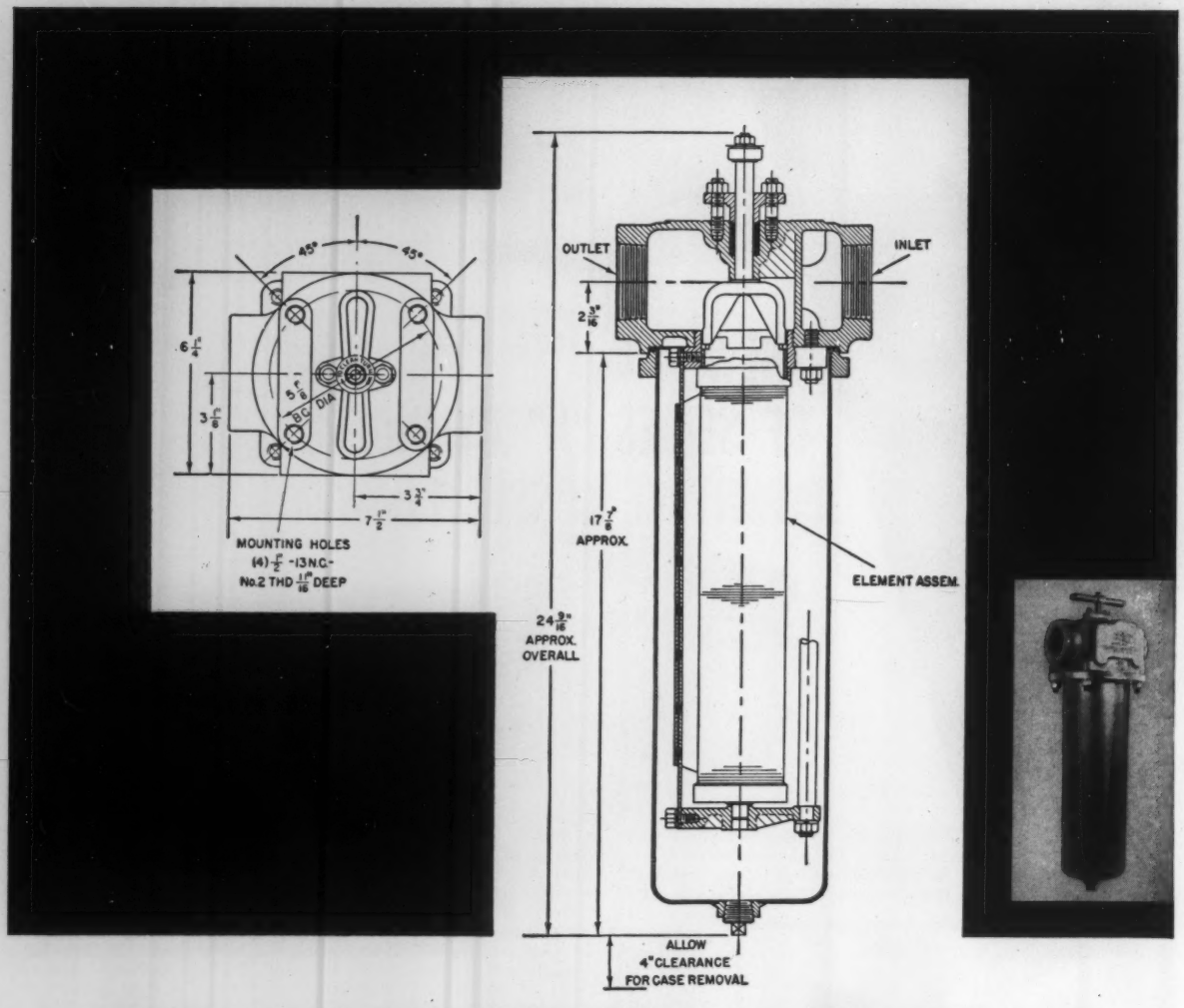
Call your nearby Hydro-Line representative today — ask for demonstration of how Power-Protection design cuts downtime.

HL CYLINDERS

HYDRO-LINE MANUFACTURING COMPANY

5600 PIKE ROAD — ROCKFORD, ILLINOIS

manufacturers of: high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • adjustable-stroke cylinders • dispensing cylinders • intensifiers • single-acting cylinders • booster cylinders



Your "special" filtration problems can be solved by standard Purolator filters

FOR EXAMPLE... This one standard Purolator filter is exactly right for all these "special" filtration problems:

inks, paints,
varnishes, machine tool coolants,
greases, vitamin solutions,
as well as fuel and lube oils.

This filter's specifications may recommend it for a problem of yours. If not, you're almost certain to find a standard Purolator filter that does meet your needs—exactly.

SPECIFICATIONS... This is Purolator filter model G-141J with simplex full flow metal element oil strainers. It is designed for primary or first stage filtration and can be installed on pressure or suction side of pump. Recommended for maximum capacities of 40 to 80 GPM, dependent on spacing which varies from .003 to .010. Relief valves set from 10-12 to 50 PSI are incorporated in several models. Motor driven knife blade to clean element can be furnished whenever conditions make manual rotation impractical. Head is made of high tensile cast iron, body of drawn steel. Inlet and outlet connections are 2″, drain plugs are provided. Maximum pressure: 125 PSI; weight: 37 lbs.

Remember, if these specifications don't match your needs, there's probably a filter that does at Purolator. Find out. Send in your problem.

Filtration For Every Known Fluid

PUROLATOR

PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

Circle 496 on Page 19

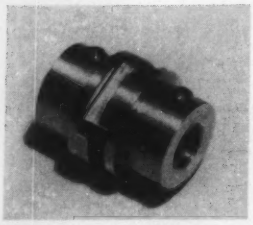
cate, enclosed instruments so that vapor given off will keep the instrument lubricated and rustfree. Porelon produced without a liquid ingredient can be used as a liquid filter. **Perma Industries Inc.,** 4169 Beverly Blvd., Los Angeles, Calif.

Circle 679 on Page 19

Miniature Couplings

have bore sizes of ⅛ to ¼ in. diam

Type T miniature precision couplings are stainless steel with nylon center block. They are also avail-



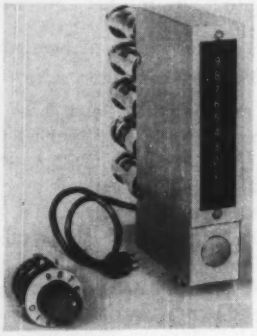
able with an oilless center block. Couplings have pin and clamp-type hubs in bore sizes of ⅛ to ¼ in. diam. **PIC Design Corp.,** 477 Atlantic Ave., East Rockaway, N. Y.

Circle 680 on Page 19

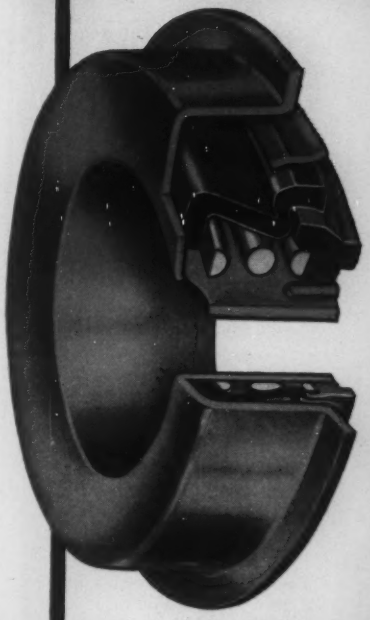
Preset Counter

is operated remotely

Model 101AR remote preset decade counting unit is controlled through the use of a five-wire cable brought out the back of the decade, terminating in a small five-pin plug. Cable can be extended to any distance, and a switch at the extremity is used to select any digit from 0 to 9. Actuating voltage can be from 6 to 24 v dc. The direct-reading unit provides an output pulse at a selected number of rates



YOU ASSURE...



✓ Greater Economy
✓ Better Performance
WITH
JOHN CRANE
SELF-ALIGNING
TYPE 11-A
Rotary Shaft
SEALS

BECAUSE:

1. **You save on production time.** The Type 11-A Seal is a low cost, compact, factory assembled unit. Its "pressed-in" cartridge-type construction makes for quick installation as equipment rolls by.
2. **One seal size fits several shaft diameters.** Retainer is so constructed that it does not contact the shaft, eliminating the need to "switch" seals when shaft specifications vary slightly.
3. **Damaging stresses are eliminated.** Since the entire unit remains stationary, the seal readily lends itself to applications involving high speed and vibration.
4. **Safeguarded against corrosion.** Metal spring utilized to maintain constant contact of sealing faces is fully enclosed in synthetic rubber bellows. This eliminates the need for costly corrosion-resistant spring materials.

"John Crane" Type 11-A Seals are recommended for temperatures to 212°F., pressures to 20 psi. Available in four stock sizes from ½" to ¾".

Contact "John Crane" engineers on your requirements today. Request illustrated catalog on complete line of seals for all services.

Crane Packing Co., 6425 Oakton St., Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Co., Ltd. Hamilton, Ont.*

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

Circle 497 on Page 19

HIGH CAPACITY SWITCH

Controls up to 4 circuits

•

DUST, OIL-TIGHT
LONG LIFE
VERSATILE
LONG OVERTRAVEL

Machine tool and other equipment applications are "naturals" for this Acro high capacity switch, which can control up to four separate circuits on either pilot or line duty. Actuator is adjustable 360° in two planes.

ELECTRICAL RATING

2 H.P. 230 Volts A.C.
1 H.P. 115 Volts A.C.
20 Amps—250 Volts A.C.

Two types available: Double Action Type actuates switch contacts when actuator is moved either side of "at rest" position. Single Action Type operates from one side of "at rest" position only. Both are designed for long life under heavy use.

AVAILABLE TYPES

Catalog No.	Circuit Arrangement	No. Terminals	Action
242-0003-03	Four circuits (two open, two closed)	8	Double
242-0011-03	Four circuits (two open, two closed)	8	Single
242-0010-03	Double circuit (one closed, one open)	4	Double
242-0012-03	Double circuit (one closed, one open)	4	Single
242-0019-03	Double circuit (normally closed)	4	Double
242-0017-03	Double circuit (normally closed)	4	Single
242-0020-03	Double circuit (normally open)	4	Double
242-0018-03	Double circuit (normally open)	4	Single

Write for complete information and application engineering help. Mention ACRO Machine Tool Switch!

Robertshaw-Fulton
CONTROLS COMPANY

ACRO DIVISION • Columbus 16, Ohio

In Canada: Robertshaw-Fulton Controls (Canada) Ltd., Toronto

New Parts

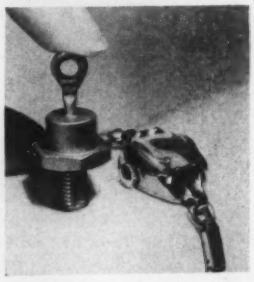
in excess of 40,000 counts per sec. Typical applications include batching, sorting, packaging, automatic counting and controlling, frequency division, and generation of precise delays. **Computer Measurements Corp.**, 5525 Vineland Ave., North Hollywood, Calif.

Circle 681 on Page 19

Silicon Rectifiers

meet rigid military mechanical specifications

New 20-amp stud-mounted 200-C silicon rectifiers, available in four types, have peak inverse voltage ratings of 50, 100, 200, and 300 v. They meet rigid military mechanical specifications. Applications include computer, airborne electronic equipment, and two-way radio



power supplies, as well as in other power supplies where size, weight and high-temperature operation are necessary. Rectifiers have a peak one-cycle surge current rating of 300 amp with operating currents up to 20 amp. The medium-current units are hermetically sealed and can be used at full ratings, since no aging occurs in the silicon. Semiconductor Products Dept., **General Electric Co.**, Clyde, N. Y.

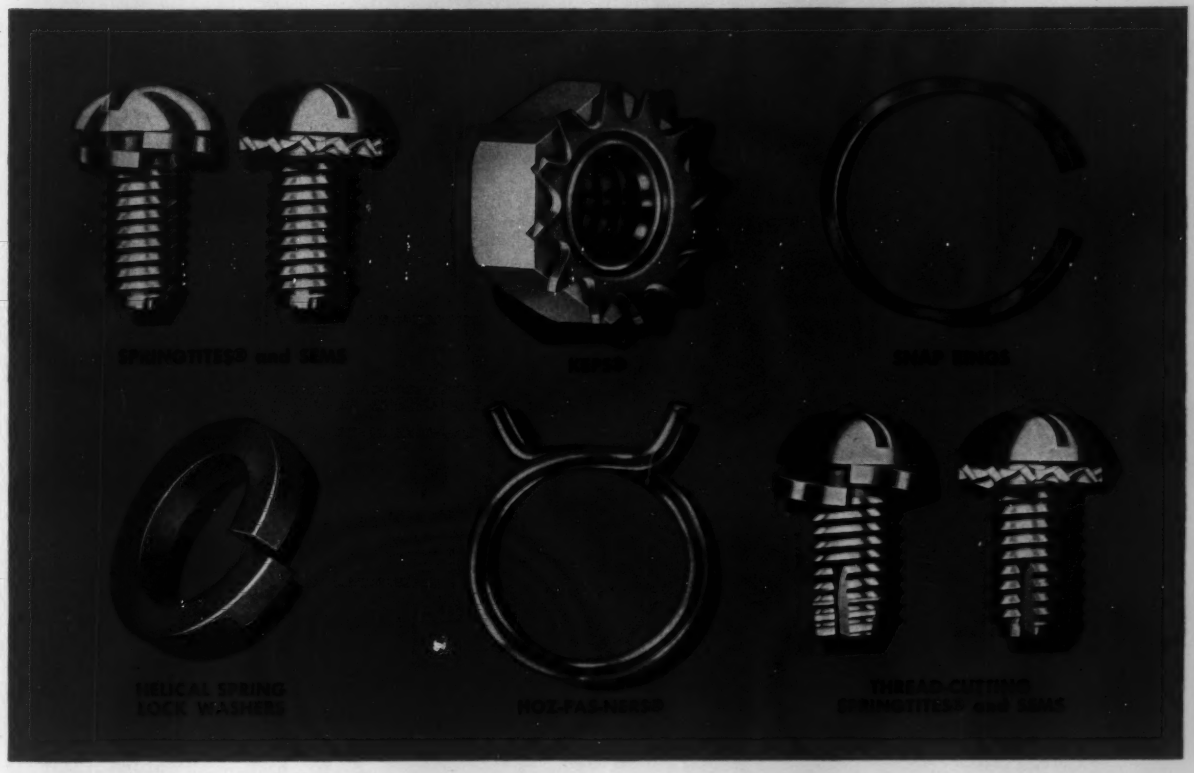
Circle 682 on Page 19

Expansion Bellows

for volumetric displacement applications

New expansion bellows have high flexibility with low spring rates and low stress. They are for volumetric displacement use, such as absorbing the expansion of oil in filled systems. Illustrated is a bellows with OD of ¾ in., solid height of 0.084 in., and spring rate of 20 lb per in., providing total dis-

WANT TO SPEED PRODUCTION ? ? ?



USE EATON-RELIANCE COST REDUCING INDUSTRIAL FASTENERS

Eaton-Reliance Industrial Fasteners are designed on the basis of time-tested principles . . . but in line with the modern concept of helping industry speed production, cut costs and improve quality.

SPRINGTITES and SEMS—preassembled screws and washers eliminate expensive hand operations.

KEPS—preassembled nuts and serrated washers.

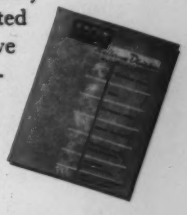
SNAP RINGS—take the place of shoulders machined on shafts and in counterbores—save man hours and material.

HELICAL SPRING LOCK WASHERS—keep tension on assemblies despite thread wear, bolt stretch or expansion and contraction.

HOZ-FAS-NERS—quickly applied to make firm connections on rubber, plastic or fabric hose.

THREAD-CUTTING SPRINGTITES and SEMS—seat firmly, reduce chance of mismating or stripping.

For more than forty-five years the Reliance Division of Eaton Manufacturing Company has been designing and producing quality fasteners for industry. You are invited to use this experience to help solve your own problems. Detailed information is included in your free copy of Engineering Bulletin 4K/3. Just send for it, or ask for a visit from one of our fastening engineers.



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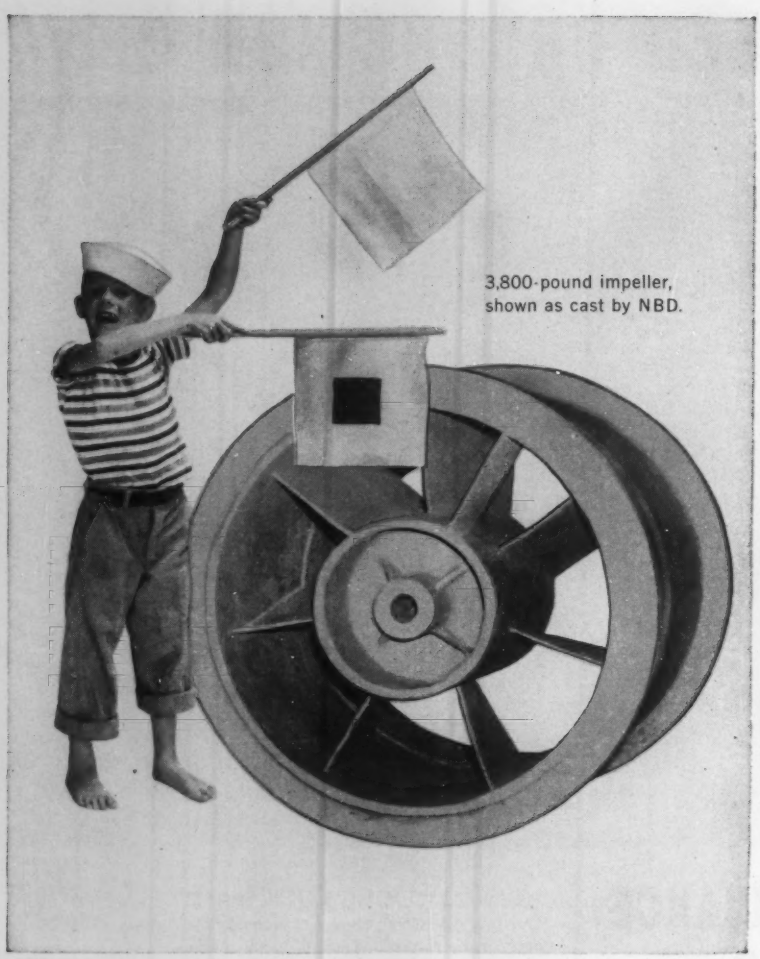
506 CHARLES AVENUE • MASSILLON, OHIO

SALES OFFICES: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Los Angeles

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers



3,800-pound impeller, shown as cast by NBD.

CALL THE MAN FROM **NBD**
FOR PUMP PARTS IN **BRONZE**

This impeller could be as big as 20,000 lbs. NBD makes pump castings any size, any shape! Housings, impellers, bushings . . . any weight up to 20,000 lbs. Machined to any degree of finish, up to 72-inch diameters. Precise tolerances held to your specifications.

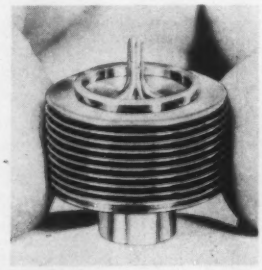
NBD specializes in bronze metallurgy; has developed more than 40 special alloys. Completely equipped for shell mold, cast-to-size, centrifugal casting.

Call or write for quote or information.

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION
717 Grant Building • Pittsburgh 19, Pennsylvania
PLANTS IN: CHICAGO • ST. LOUIS • MEADVILLE, PA.

New Parts



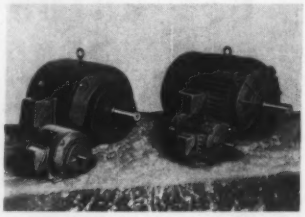
placement of 0.5 cu in. Other sizes provide displacement to 700 cu in. **Belfab Corp.**, Ramah Circle, Agawam, Mass.

Circle 683 on Page 19

Totally Protected Motors

in large NEMA frame 364U through 445U

Totally protected, Series D ac motors are available in the new large NEMA Frame 364U through 445U. Foot-mounted and footless horizontal models in the 360 frame diam are furnished in all standard enclosures for operation on 208 to 550-v ac. Motors can be specified in many speeds with Class A, Class B, or high-temperature Class H insulation. Part-winding starting



is available for air conditioning and other applications. Larger frame motors are shown in back of their smaller counterparts. **Reliance Electric & Engineering Co.**, 24701 Euclid Ave., Cleveland 17, Ohio.

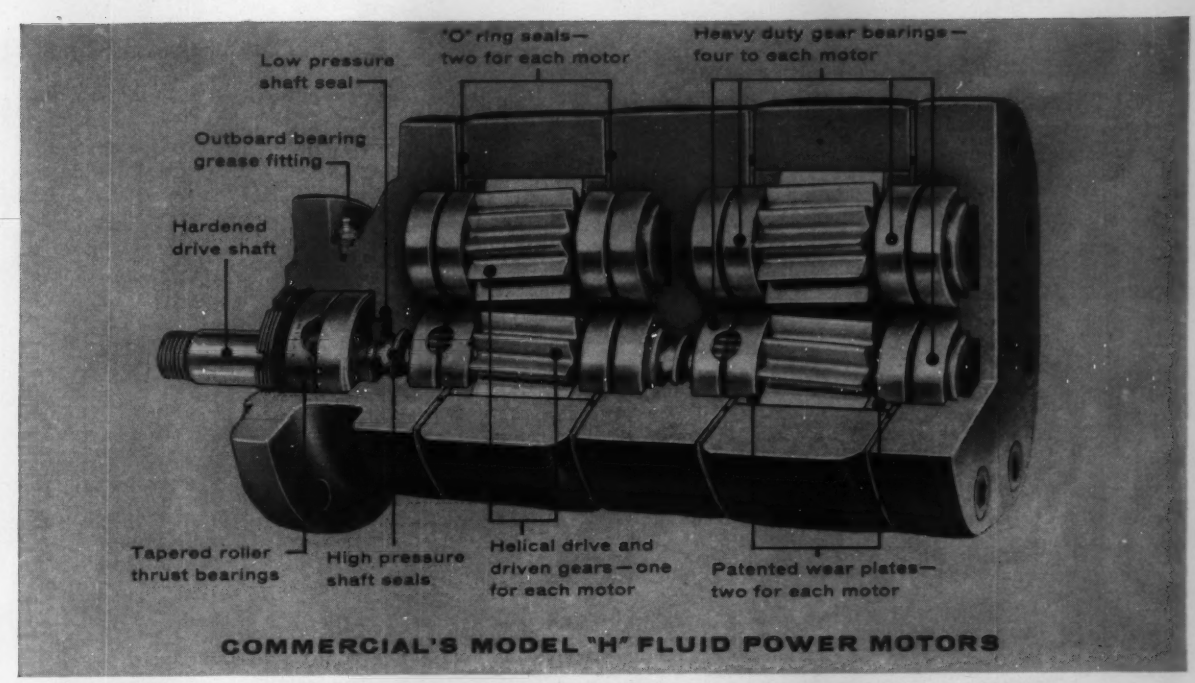
Circle 684 on Page 19

Grommet-Seal Combination

is self-locking unit for holding wire

Grom-Lok is a flexible-rubber grommet which rolls back on itself to form a dust and moisture-proof seal. Once snapped into place, it holds a wire tightly and withstands a 35 to 50-lb pull. Easy to install, a pull on the wire snaps

Circle 500 on Page 19


Low pressure shaft seal
"O" ring seals—two for each motor
Heavy duty gear bearings—four to each motor
Outboard bearing grease fitting
Hardened drive shaft
Tapered roller thrust bearings
High pressure shaft seals
Helical drive and driven gears—one for each motor
Patented wear plates—two for each motor

COMMERCIAL'S MODEL "H" FLUID POWER MOTORS

New ideas in fluid power motors

Multiple-speed drive simplified

Efficient operation of heavy mobile equipment frequently involves multiple speeds. Not so efficient, however, is the shifting of gears, the power take-offs, clutches and gear transmissions involved in gaining these desired speed levels with mechanical drives—not to mention the constant maintenance headaches these same drives entail.

Pictured above is one Commercial fluid power oil-hydraulic motor that now delivers low and high speeds efficiently—completely eliminates the problems mechanical drives ordinarily involve.

Two motors work in tandem

This Commercial Model "H" tandem motor actually involves two single motors of equal output mounted on one common drive shaft. When fluid power from the pump source is directed by simple valving into just one of the single motors, the shaft rotates at the high speed. The other single motor on the same shaft receives no input and therefore merely turns. When low speed is required, the total fluid power delivery from the pump is valved into both of the single motors. And of course motor torque at this reduced speed is doubled. This simplified control of two speeds—both low and high—is possible in either direction, forward or backward.

Each of the single motors in this Model "H" tandem motor has one-inch gears. With a fluid power input of about 15 gpm at 1200 psi, for example, when one of the single motors receives the entire input, rotation is 1200 rpm. When the same input is split between the two equal size single motors, rotation is 600 rpm.

Model "H" motors are available with gears in widths of 1", 1¼", 1½", 2", 2½" and 3". Any combination of gear sizes is practical.

More than two speeds

Even three speed operation can be obtained with Commercial double tandem motors when gears of different widths are used in each single motor. High speed operation results when the full pump delivery is valved to the motor with the smaller gears, intermediate speed when it is all directed to the larger gear motor, and slow speed when valved to both motors. One single motor having three-inch gears operating at 1600 psi at a speed of 1200 rpm would develop about 50 h.p. Commercial Model "H" motors are recommended for continuous duty operation at pressures up to 2000 psi and speeds up to 1800 rpm.

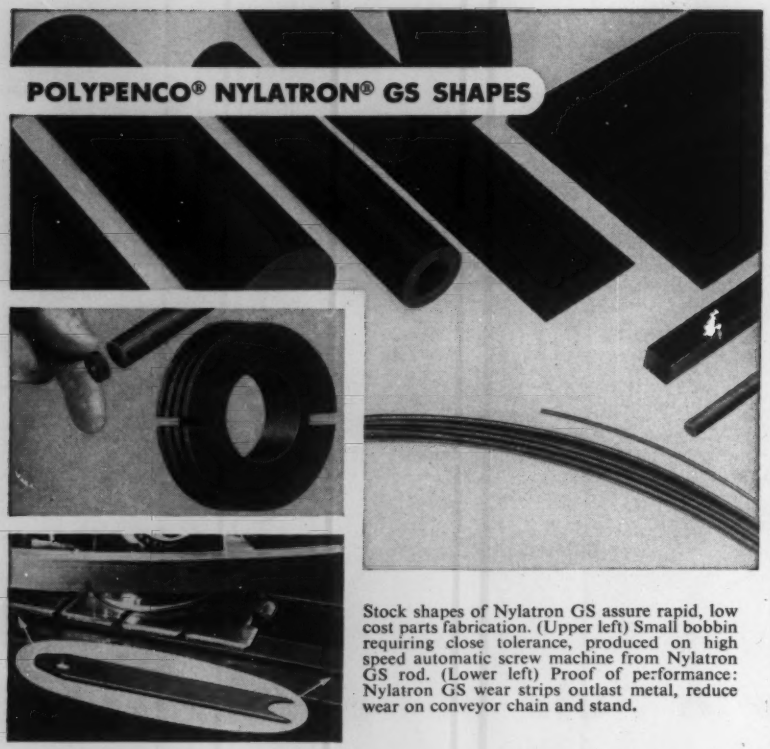
Engineering help available

Be sure to send for your copy of Commercial's "Oil-Hydraulic Motors Catalog H-4". Further information on Commercial's complete line of other fluid power components—valves, pumps and cylinders—is also yours for the asking, as is technical help and assistance from Commercial on fluid power applications.

Address inquiries to The Commercial Shearing and Stamping Company, Dept. S-48, Youngstown 1, Ohio.

COMMERCIAL
shearing and stamping

Circle 501 on Page 19



Stock shapes of Nylatron GS assure rapid, low cost parts fabrication. (Upper left) Small bobbin requiring close tolerance, produced on high speed automatic screw machine from Nylatron GS rod. (Lower left) Proof of performance: Nylatron GS wear strips outlast metal, reduce wear on conveyor chain and stand.

Special properties of NYLATRON GS nylon provide parts with unusual wear life

One of the newest industrial plastics available to designers is POLYPENCO Nylatron GS nylon —supplied in standard stock shapes. Nylatron GS is a molybdenum disulphide filled nylon composition*. This special formulation results in a product with proven property advantages:

Greater Rigidity
Parts have higher modulus of elasticity, show less deformation under load than nylon 101.

High Heat Distortion Temperature
Nylatron GS parts have higher heat distortion temperatures than standard nylon 101.

Low Thermal Expansion
Coefficient of thermal expansion is approximately 60% of nylon 101.

Low Surface Friction
When wear parts must run dry, Nylatron GS parts operate without lubrication.

High Wear and Abrasion Resistance
Part surfaces resist abrasion and demonstrate long wear in contact with metals.

The chemical and electrical properties are similar to nylon 101.

Nylatron GS is available in all standard shapes and sizes including rod, strip, tubing, tubular bar and plate. It is also available in powders for molding. Write today for performance and application data on POLYPENCO Nylatron GS nylon.

Patents applied for

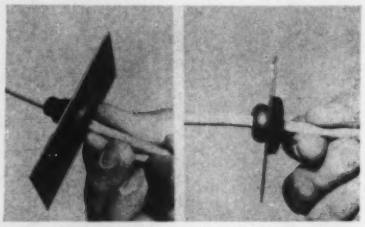
THE POLYMER CORPORATION OF PENNA.
Reading, Pa.
Export: Polypenco, Inc., Reading, Pa., U.S.A.

POLYPENCO

POLYPENCO Nylon, POLYPENCO Teflon†, NYLAFLOW and NYLATRON® GS †DU PONT TRADEMARK

New Parts

the unit into place without the use of auxiliary anchors. Fastener can be made from any commercial rubber or neoprene, and accommodates any size wire. It is suited



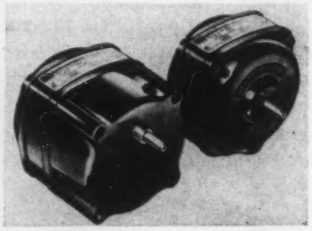
for appliances, electronic equipment, aircraft, and automotive applications. **Argosy Industries,** 67 May Court, Chagrin Falls, Ohio.

Circle 685 on Page 19

Reversible Motor

is two-speed, subfractional-horsepower unit

RBC-2514 two-speed reversible subfractional-horsepower motor has basic speeds of 1800 to 3600 rpm. It is available with standard gear reductions from 3:1 to 3600:1. Basic torque ratings at 115-v, 60-cycle, 3600-rpm synchronous range,



continuous duty, are from 0.15 to 0.5 oz-in. **Holtzer-Cabot Motor Div.,** National Pneumatic Co. Inc., 125 Amory St., Boston, Mass.

Circle 686 on Page 19

Heavy-Duty Flasher

for aircraft and industrial service

Type BF flasher combines two thermal relays and one magnetic relay, all hermetically sealed, in a circuit in which load current is handled by the magnetic relay. Thermal relays govern on and off portions of flashing cycle, which is unaffected by load current or load-contact erosion. Unit is suitable for aeronautical use and in-

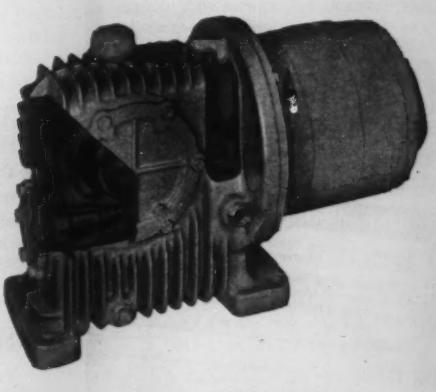
Here's a whole new family of fine GEARMOTORS by Cone-Drive Gears

MOUNT THEM ANYWHERE—FLOOR, WALL, CEILING, OR HANG THEM ON A SHAFT...

. . . there's a Cone-Drive gearmotor for every need. Look at the extensive line of space-saving, power-packed models now available. No matter whether you're faced with floor, wall, ceiling, or shaft mounting at any angle, Cone-Drive Gears has a gearmotor for the job.

It's the most versatile line available PLUS big power capacity in a really compact package. Double-enveloping worm gears, pioneered and proven by Cone-Drive Gears, are combined with a helical primary and extra-large taper roller bearings in a rugged finned housing to give you a power package without equal. You can select any model in any of 27 standard output speeds (7.3 to 525 rpm at 1750 rpm input) in capacities from 1 through 25 horsepower.

Best of all, Cone-Drive gearmotors are priced right down with units that can't deliver nearly as much performance and versatility. Check your nearby Cone-Drive representative or write today for new Catalog 57 containing complete specifications.



Cutaway view of typical Cone-Drive gearmotor illustrates use of double-reduction gear train for increased output power. Note also large taper roller bearings and heavy-ribbed housing.

CONE-DRIVE GEARS Division, Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, Michigan

Circle 503 on Page 19

• A good chair is like a good wife...if you choose with care, it will look after your comfort and aid you in your work for a long time to come

Cramer CHAIRS ARE

GOOD CHAIRS

Scientifically planned to aid YOU in your work . . . designed to support you comfortably whether you're chewing your pencil or bent over hard at work . . . engineered from the quality materials YOU would recommend, with independently adjustable seat, back and footring to conform to your physique . . . and with removable, replaceable covers in a wide range of fabrics and colors to match YOUR decorating plan.

Pictured, Cramer Hi-Model 4D-22T with forward-tilt seat; others available. All are low-gravity balanced for safe use on casters if desired.

LIKE MORE INFORMATION?

Cramer Posture Chair Co., Inc., Dept. MD-117 1205 Charlotte, Kansas City 6, Mo.

Please send me complete facts on the Cramer Hi-Model chairs designed for working architects and engineers.

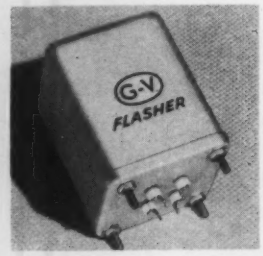
Name _____

Firm _____

Address _____

Circle 504 on Page 19

New Parts



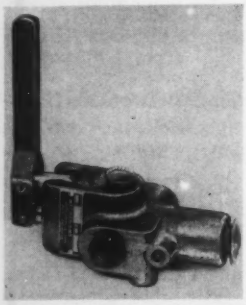
dustrial service. Temperature range is −65 to 125 C. Flasher withstands aircraft vibration and shock requirements. Standard units are available for 26.5 v dc and 115 v ac energization, and for 20, 60, and 90 flashes per minute with equal on and off times. **G-V Controls Inc.,** 28 Hollywood Plaza, East Orange, N. J.

Circle 687 on Page 19

Hydraulic Control Valve

is five-way unit

No. 1776 five-way hydraulic control valve is designed for complex hydraulic circuits in materials-handling equipment. In the center position, valve connects straight through to the single-acting cylinder with other ports closed. In either of the end positions, it connects to a double-acting cylinder



and closes the port to the single-acting cylinder. Valve illustrated is for pressures to 2000 psi; others can be furnished for higher pressures. **Mechanisms Co.,** 118 E. 2nd St., Uhrichsville, Ohio.

Circle 688 on Page 19

Molded Activated Carbon

in cube and wafer shapes

Dustfree, molded shapes are formed from powdered, highly adsorbent activated carbon bonded with an

ELECTRIC

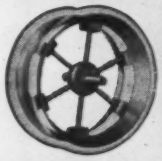
Wheels · Axles · Spindles

DIVIDED WHEELS

Generally used as dolly, tail or caster wheels

FOR TRUCK TIRES

Full drop center rim to utilize used truck tires on larger implements

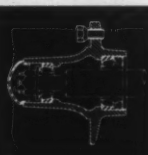


PLANTER WHEELS

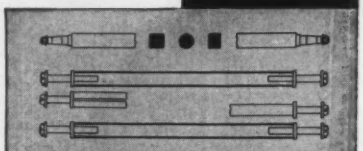
Steel rim or for use with planter rubber tires

SIX BOLT SERIES

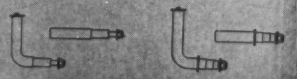
Light and heavy—widest range of implement use



Four bolt series for light implements



Hub and bearing combinations available. Stub spindles and full length axles.



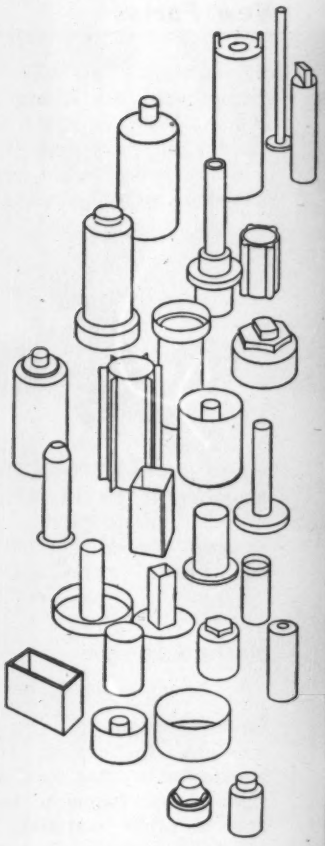
Our Engineers Invite Your Inquiries

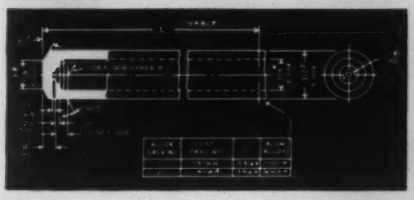
ELECTRIC WHEEL COMPANY

DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY

2809 SPRUCE · QUINCY, ILLINOIS

Circle 505 on Page 19





small part, big saving–thanks to an **ALCOA IMPACT**

This interesting little Alcoa® Impact does a big job in a thermostat control designed for use with electrically heated appliances. It is the probe which forms the sensing element of the thermostat. Changes in the length of the probe control the opening and closing of the unit's electrical contacts.

Considering the close tolerances and extreme length-to-diameter ratio of 15 to 1, most designers would visualize this part as a screw machine product. Fabricated on a screw machine, it would call for a drastic deep-drilling operation into solid bar stock, plus a further chamfering and cutoff operation on the closed end. In short, it would be a fairly expensive and troublesome part to produce.

As an Alcoa Impact, however, just one punch of the press delivers a complete, close-tolerance part in a fraction of a second. The only finishing operation required is the cutting of the piece to the exact length required. The production economies are easy to see. And remember, just about any closed-end tubular part or cup-shaped part can be produced by impact extrusion. No matter how intricate, if it can be made as an Alcoa Impact, it is fabricated in one smack in a split second.

If you think you should be considering the possibility of using an Alcoa Impact, send for our helpful design manual, *Alcoa Impacts—Metal in Motion*. If you have a problem you want to talk about right now, call your nearest Alcoa sales office, (you'll find it listed under "Aluminum" in the Yellow Pages of your telephone directory) and an Alcoa sales engineer will be glad to help you out. Aluminum Company of America, 1991-X Alcoa Building, Pittsburgh 19, Pa.

Some Impact Rules of Thumb—
Check your problems against this list:

1. Parts requiring hollow sections—either tube or cup-shaped with one end closed.
2. Parts with walls or surfaces requiring zero draft.
3. Parts requiring lengths up to eight or ten times the diameter.
4. Parts requiring the strength of forgings.
5. Parts requiring tolerances down to $\pm 0.005''$.
6. Parts requiring ribs, bosses or fins as integral parts.
7. Parts requiring low unit cost in mass production. (Often the savings in machining, fabrication and assembly made by impacts amortize tooling in relatively short runs.)

ALCOA ALUMINUM IMPACTS

YOUR GUIDE TO THE BEST IN ALUMINUM VALUE

NEW! "ALCOA THEATRE"
Exciting Adventure
Alternate Monday Evenings

Circle 506 on Page 19

asg
UNIVERSAL JOINTS

available in 13 sizes
with bored or solid hubs

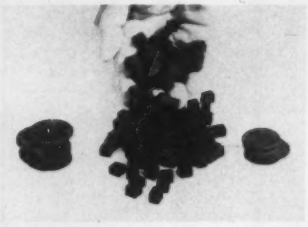
You can get ASG Universal Joints directly from stock in 13 sizes with bored or solid hubs ranging in diameter from .375" to 4.000". Special bores, bores with keyways or setscrews are available upon special order.

ASG Universal Joints are ruggedly constructed of heat treated alloy steel. Matching or mating parts are precision ground to permit easy interchangeability of components. Self-locking retaining rings on small pins simplify assembly and disassembly. Joints of 7/8" length and longer have snap ball oilers. Smaller joints have oil holes. Oil enters at center of rotation to assure thorough lubrication of moving parts.

Send today for Bulletin No. 527 describing the full line of A.S.G. Universal Joints available from your nearest distributor.

AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY • HARVEY, ILLINOIS, U.S.A.

organic resin. Two sizes of wafers are produced, 3 x 33 mm, and 9 x 38 mm. Cubical shape measures about 3/8 in. on a side. It is used in hermetically sealed relays and precision instruments to adsorb



vapors driven off from the plastic insulation of the instrument wires by heat generated during operation. **National Carbon Co.**, 1300 Lakeside Ave., Cleveland 14, Ohio.

Circle 689 on Page 19

Mastic Adhesive

for bonding plastic foams

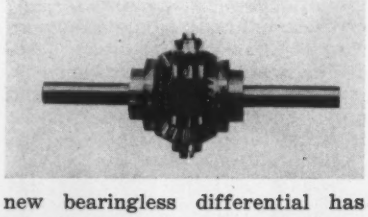
Bondmaster G458 is a high-strength, fast-drying, trowelable mastic for bonding rigid and semi-rigid plastic foams to themselves and to other materials such as wood and metals. It is available in black or in neutral cream color. The adhesive resists humidity and freezing temperatures. Parts to which the adhesive has been applied can be mated almost at once. Mastic can be applied with a saw-tooth spreader, notched trowel, or spatula. **Rubber & Asbestos Corp.**, 225 Belleville Ave., Bloomfield, N. J.

Circle 690 on Page 19

Bearingless Differential

has backlash of 30 min of arc

Incorporating a stainless-steel spider and bronze bevel gears, with both 48 and 72 diametrical pitch,



new bearingless differential has a backlash of about 30 min of arc. It tumbles within 1 in. plus 1/32

THIS AIR CYLINDER ACTS 78 MILLISECONDS FASTER

Take a 2½" bore conventional air cylinder, connect it to a remote valve with 6 feet of ⅜" diameter hose. *123 milliseconds* after the valve is operated, the air cylinder's piston begins to move.

Now take a Bellows Air Motor (the air cylinder with the *built-in* valve) of the same bore. The response time for the Bellows Air Motor is *45 milliseconds* . . . only 27% of the time required by the remote-controlled air cylinder.

Multiply that time-saving over an eight-hour shift . . . using, say, a six-parts-per-minute operation . . . and you receive 44 more parts each shift from your machine when you use a Bellows Air Motor with the built-in valve.

"Forty-four more parts each shift?" Not many, perhaps. But the multipliers . . . number of machines, number of shifts, length of production run, any one or all of them . . . can send the "44" up into respectability very quickly. In fact, it can mean 33,000 more parts per year from a single machine.

Quick response is only one of many advantages integral valving offers the user of air cylinders. Positive speed control; uniform power thrust; less air consumption; no cumbersome piping . . . all of these make an impressive total of cost saving advantages.

GET THE FULL STORY — Write for Bulletin BM-25. Twenty pages of helpful data every production man can use in his battle for lower costs. Address Dept. MD-1157, The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd., Toronto, Ontario.

9248

The Bellows Co.
AKRON 9, OHIO

Circle 508 on Page 19

Take ALL the Problems Out of Your Variable Speed Requirements

Put Lovejoy's exclusive individualized service to work for you...a complete line of variable speed pulleys and transmissions—plus personalized engineering guidance to assure full satisfaction.

- Speed ratios: up to 10 to 1
- Horsepowers: fractional to 15
- Constant belt alignment
- Instant speed changes while equipment is running
- Easily installed on new or old equipment.

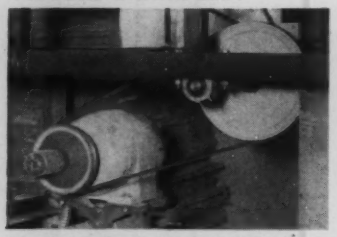
Here's how it works...

a simple and convenient two-step plan:

❶ Lovejoy sends you full information on the types of variable speed pulleys and transmissions available . . . along with a guide sheet to help you supply us with pertinent information on the type you need and the service you require.

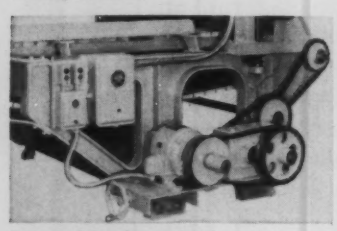
❷ Depending on your requirements, Lovejoy rushes recommendations, blue prints, suggested solutions to problems . . . or, if you desire, will send a representative to give you first-hand assistance. For standard or relatively simple applications, cost quotations can be furnished immediately.

TYPICAL EXAMPLES:

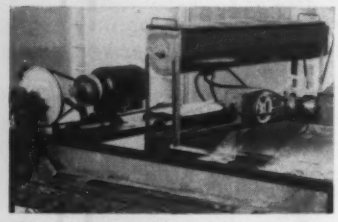


Type 160 Pulley and No. 200 Tilting Motor Base proved the right combination for a mailing machine.

Type 135 Pulley meets all requirements on a vibrating machine.



Proper drive for a slat bed rip saw is provided by a Type 302 Pulley.



This Lovejoy "double" solved a grading machine problem—Type 145 Pulley and No. 2 Select-O-Speed.

Save time and expense. Get your Variable Speed Pulley Guide by requesting Form 118F today.

LOVEJOY FLEXIBLE COUPLING CO.

4818 WEST LAKE STREET • CHICAGO 44, ILLINOIS

New Parts

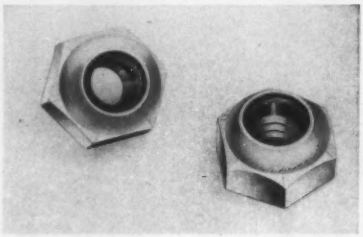
in., and any standard precision hubless gear can be assembled to it. The 48-pitch unit is available with 0.1874-in. shaft; 72-pitch model has a 0.1240-in. shaft. Shaft projection up to 4 in. is included, with longer shaft units available on request. **Dynamic Gear Co. Inc.,** 20 Merrick Rd., Amityville, N. Y.

Circle 691 on Page 19

Lock Nuts

contain molded nylon compression collar

Lock nuts have a die-cast zinc-alloy hex-nut body, and molded nylon compression collar as the locking element. Locking element maintains a constant grip on screw threads, dampens vibration, seals



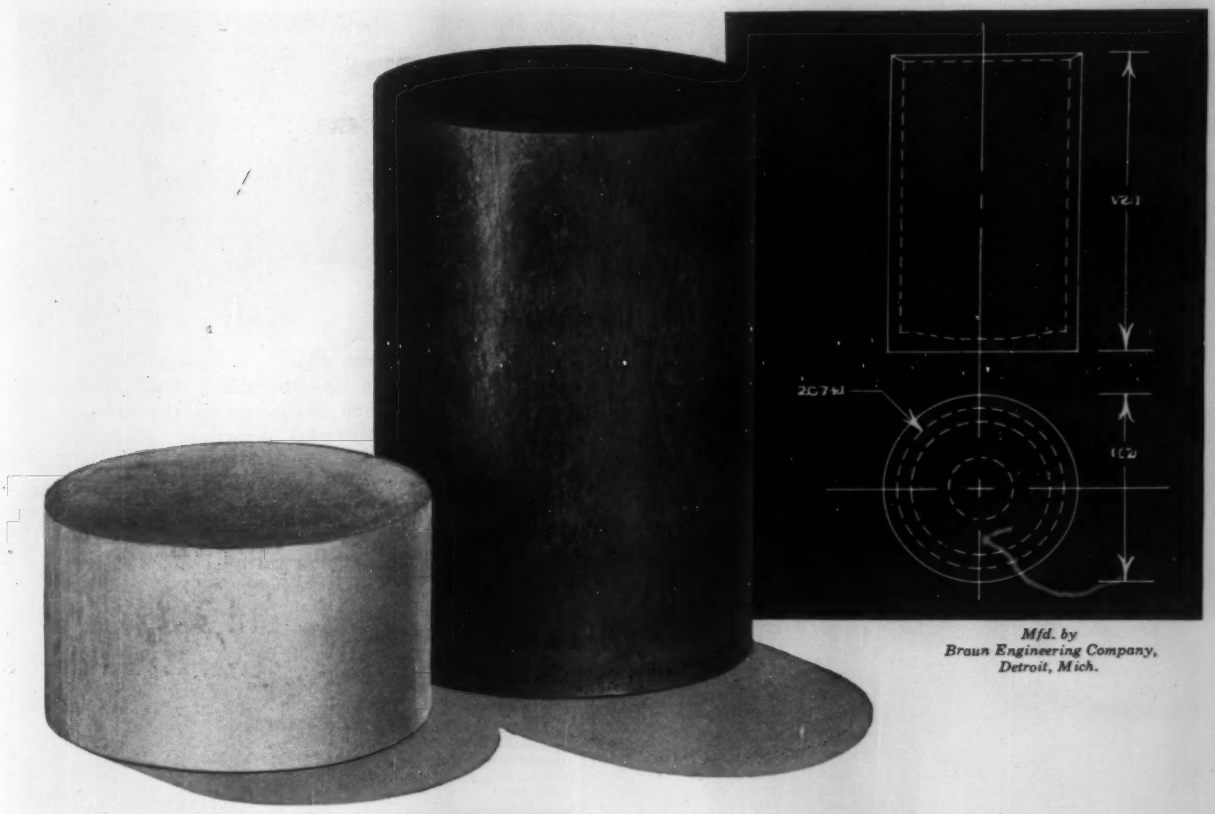
out moisture, and resists loosening. Collar tends to return to its original shape when removed from screw permitting reuse without appreciable reduction in locking torque. Lock nuts will not damage mating screw threads. Body is rustproof and corrosion resistant. Collar is impervious to almost all chemicals, solvents, and weathering conditions. Nuts are available in thread sizes from No. 4 to ½ in. **Gries Reproducer Corp.,** 400 Beechwood Ave., New Rochelle, N. Y.

Circle 692 on Page 19

Inertia Switch

is actuated by thrust, impact, or vibration

Originally designed for aircraft and missile uses, 1SA1 inertia switch provides full-time protection for unattended industrial equipment. It is an automatic device that is actuated by thrusts, impacts, or excessive vibrations. Once actuated, switch remains operated and cannot be jarred back into an unactuated position. To



Mfd. by
Braun Engineering Company,
Detroit, Mich.

EXTRUDED...*and sold for less than the raw stock used to cost!*

Cold extrusion of steel means big reductions in material, machinery, and time. Frequently, as in the case of the automotive motor mount above, the part is made by cold extrusion for about the cost of the raw metal used in conventional methods.

More and more, manufacturers are turning to cold extrusion as a cost cutting, simplified method of making quality parts. Machining is cut to a bare minimum and scrap virtually disappears. "Impossible" jobs are being mass produced at high rates and a lot of the "impossibles" have become production runs only because of Bonderite and Bonderlube.

These two remarkable aids in cold extrusion make metal flow like magic. More severe deformations are possible. Tool and die life are multiplied. Rejected parts are few and far between. Production speeds are greatly increased. Smooth finishes are easily achieved and maintained.

The Parker cold forming staff can give you expert help in the technique of cold extrusion.

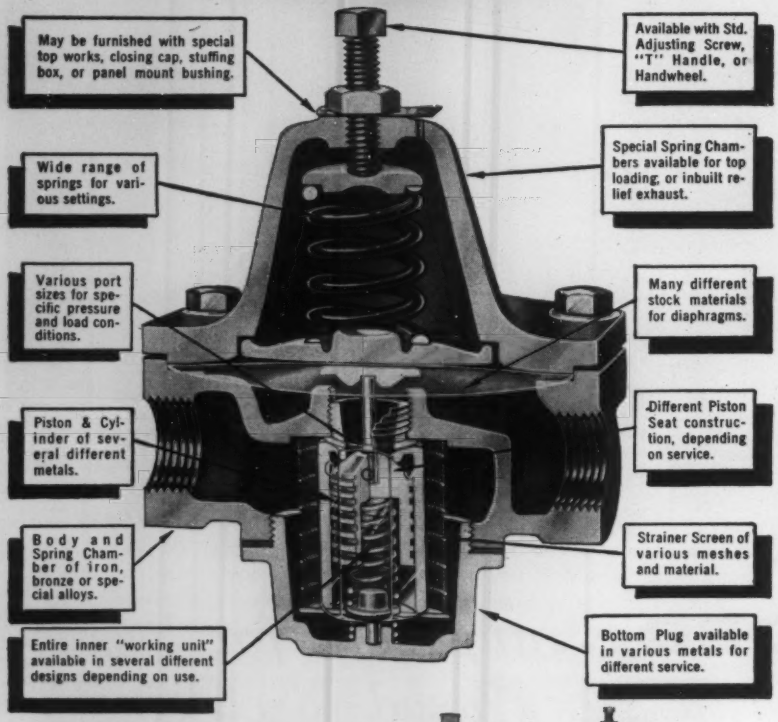
Since 1914 — leader in the field

PARKER RUST PROOF COMPANY
2193 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

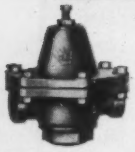
CASH ACME here's the correct answer to your difficult pressure reducing problems!


May be furnished with special top works, closing cap, stuffing box, or panel mount bushing.
Available with Std. Adjusting Screw, "T" Handle, or Handwheel.
Wide range of springs for various settings.
Special Spring Chambers available for top loading, or inbuilt relief exhaust.
Various port sizes for specific pressure and load conditions.
Many different stock materials for diaphragms.
Piston & Cylinder of several different metals.
Different Piston Seat construction, depending on service.
Body and Spring Chamber of iron, bronze or special alloys.
Strainer Screen of various meshes and material.
Entire inner "working unit" available in several different designs depending on use.
Bottom Plug available in various metals for different service.

Here's How: With over 1,017 models and modifications of Cash-Acme's *standard* Type B Pressure Reducing Valve available and already in high production, the *right* regulator can usually be quickly selected from stock to do the job you require. This offers important cost savings as delays, special tooling and custom design and engineering are eliminated.

Do as other cost conscious engineers and purchasing men are doing and switch to CASH-ACME.

A fact-jammed eight-page bulletin, with honest and accurate capacity charts, is available free of charge. Write today.



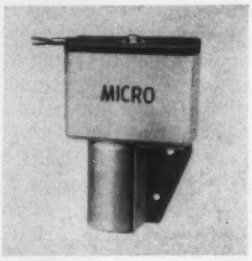
Type "B"—Rugged Industrial Type Pressure Reducing Valve ... A truly *universal* piece of equipment. Standard models for:

- STEAM
- HOT WATER
- COLD WATER
- AIR
- LIGHT OIL
- NO. 6 OIL
- AMMONIA
- DIFFERENTIAL REGULATOR
- WITH INBUILT RELIEF
- AIR OR OIL TOP LOADING
- PANEL MOUNTING

FOR THE *Correct Answer* CASH AUTOMATIC VALVES ACME

A. W. CASH VALVE MANUFACTURING CORP.
6613 E. Wabash Ave., Decatur, Illinois

New Parts



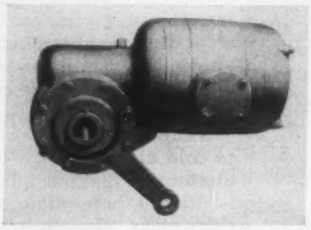
reset switch, a manual reset button is provided. Unit operates when subjected to thrust in any horizontal direction. Thrust impulse under minimum duration of 1/30 sec. will not actuate switch. Force-of-actuation settings can be supplied from 1.5 to 10 g or more. Electrical rating is 1 amp, 6 v dc. **Micro Switch,** Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle 693 on Page 19

Gear Motors

have shaft-mounted design

Shaft-mounted right-angle gear motors are rated from ¼ through 5 hp. Shaft-mounted design eliminates all intermediate transmission elements, such as couplings and sprockets. Utilizing aluminum construction, the gear motors provide a compact, space-saving installation suitable for light ma-



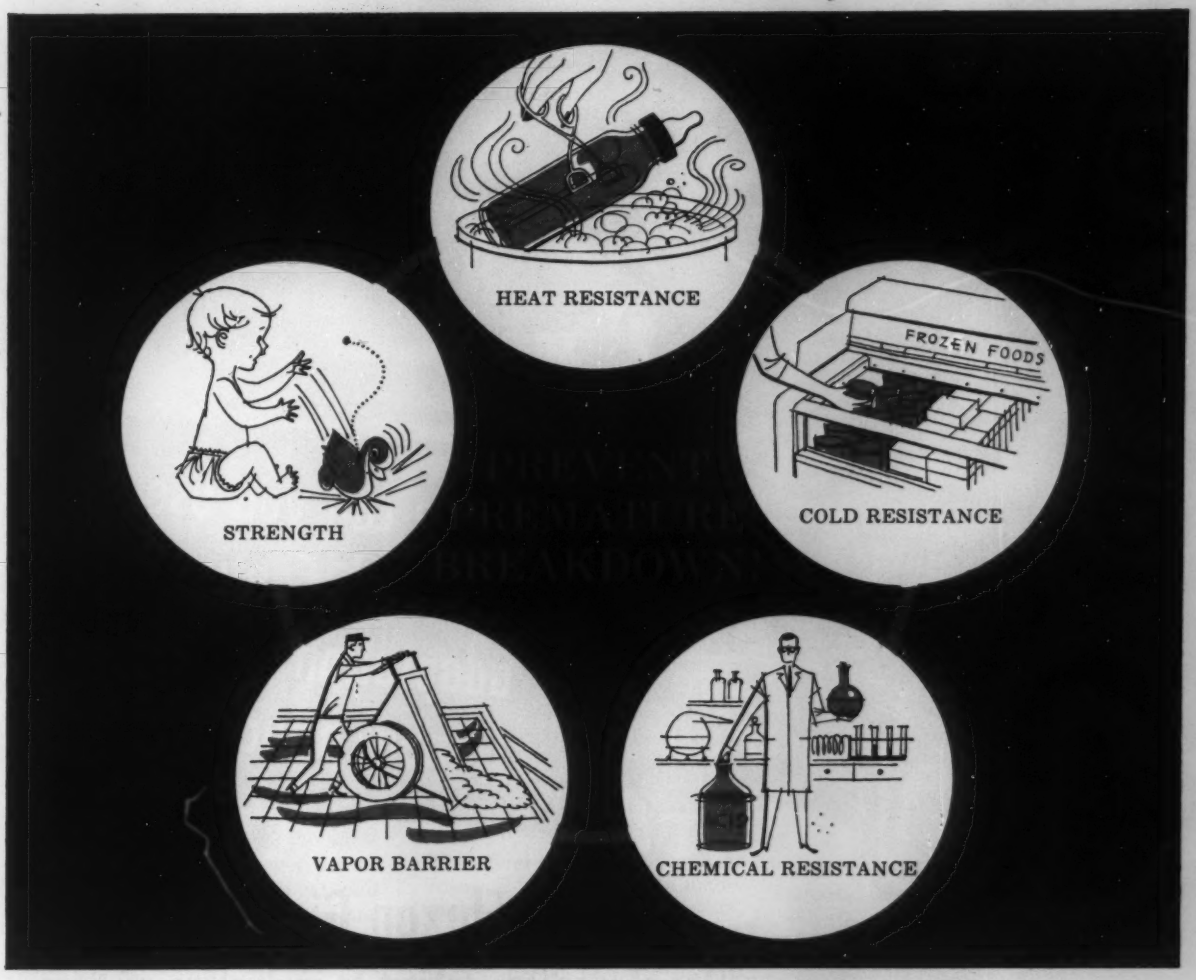
chinery or for use in small areas. Motors meet all AGMA specifications, and are built for rugged, continuous duty. **Sterling Electric Motors Inc.,** 5401 Telegraph Rd., Los Angeles 22, Calif.

Circle 694 on Page 19

Valve Stem Packing

for temperatures to 500 F

Style 5022 packing material is a molded-type valve stem packing ring of copper wire-inserted asbestos yarns which are braided and



Improve quality and performance ...with GREX*

Minimize the danger of premature product breakdown . . . upgrade quality and performance! Always specify GREX, the new high density polyethylene! GREX offers you a combination of properties far superior to those found in most plastics used today, yet cost is low.

GREX gives you exceptional impact and tensile strength, that assure long service and hard wear. High heat and cold resistance lets you boil GREX without distortion . . . freeze it without brittleness.

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GREX is unaffected by most acids and chemicals and efficiently resists moisture vapor transmission. You can shape it into most delicate designs, yet it stays strong and rigid in thin sections.

Look into the many ways GREX versatility and quality can help you overcome the breakdown problem! Just fill out the handy coupon and mail!

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225 Allwood Road, Clifton, New Jersey

Please send more information about new GREX high density polyethylene. I am interested in these uses:

.....

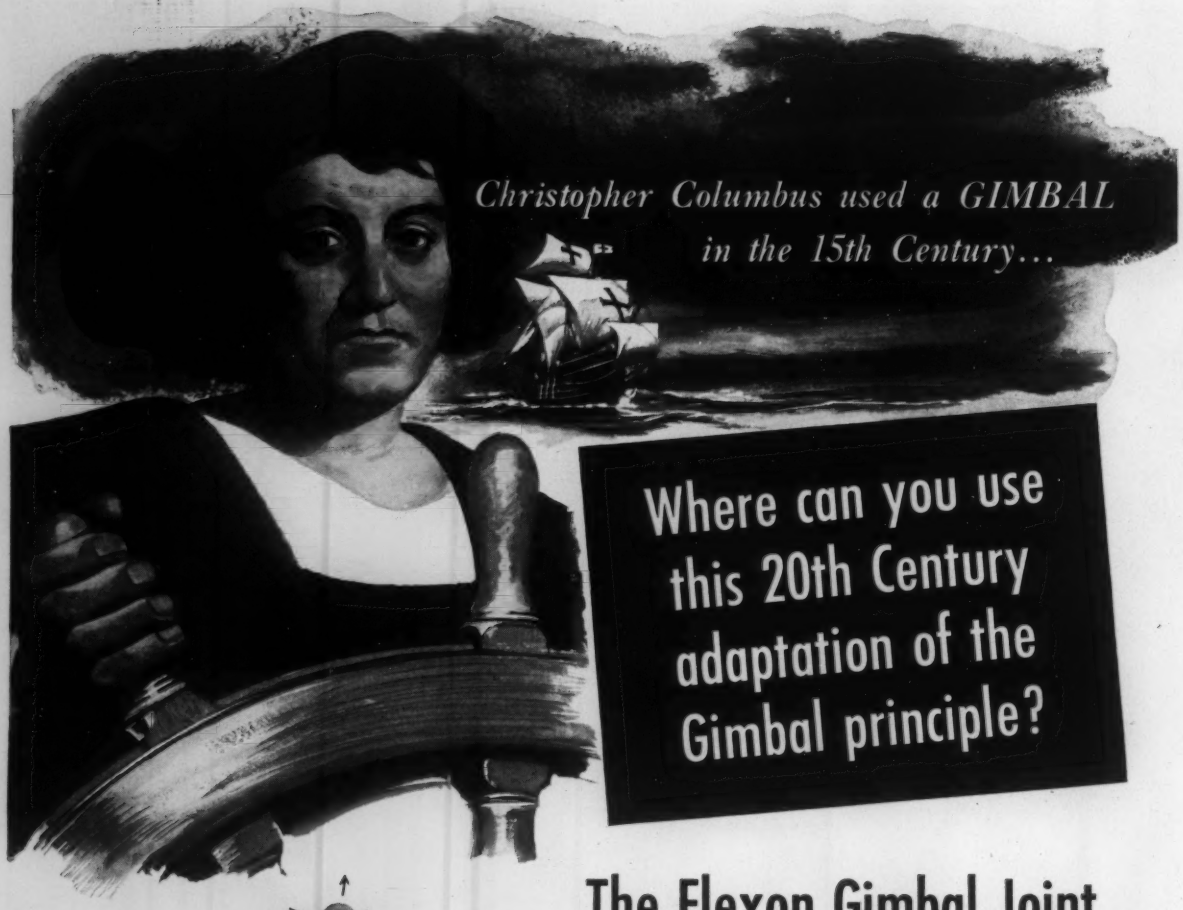
NAME.....TITLE.....

COMPANY.....

ADDRESS.....

CITY.....STATE.....

Circle 512 on Page 19


Christopher Columbus used a GIMBAL
in the 15th Century...
Where can you use this 20th Century adaptation of the Gimbal principle?

The Flexon Gimbal Joint...

for connections subject to multiplane motions

Columbus' familiarity with the gimbal was limited to the mounting for his compass. It was a device that permitted the compass to incline freely in any direction and thereby remain level regardless of the attitude of the ship.

This time-proven principle was overlooked by designers for many years. However, to meet the critical demands of supersonic aircraft and missiles, Flexonics Corporation has revived it in the form of the Flexon Gimbal Joint.

In aircraft, the Flexon Gimbal Joint is used in piping and ducting to meet problems of thermal expansion, installation misalignment, air frame deflection and high end loads. We think that you, too, may have a use for such a unit in the design of your product.

If you have a connection problem involving radial motion, we would appreciate the opportunity to discuss the possibilities of the Flexon Gimbal Joint with you.

X-1

10 plants to serve you in the United States and Canada

Flexonics Corporation

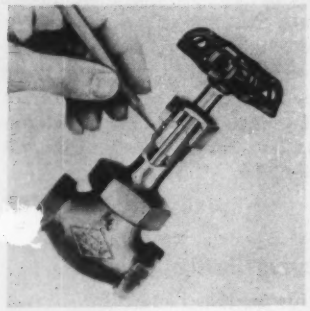
INDUSTRIAL PRODUCTS DEPARTMENT

1339 S. THIRD AVENUE • MAYWOOD, ILLINOIS

In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario

Circle 513 on Page 19

impregnated with Teflon suspensoid and die-formed into rings. Teflon provides mechanical strength and extreme toughness, acts as a lubricant, and provides heat resistance to 500-F temperatures.



Material exhibits low flow under high pressure and is chemically inert and noncontaminating. **Garlock Packing Co.**, 412 Main St., Palmyra, N. Y.

Circle 695 on Page 19

Electrical Insulation Tubing

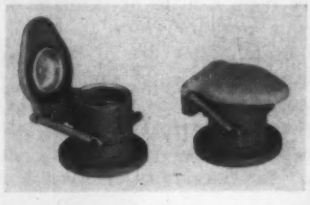
has excellent flexibility

Ben-Har silicone varnish tubing is made from braided, glass filament fibers, with antifray treatment, and impregnated and completely coated with unmodified silicone varnish. Tubing has excellent flexibility and can be bent to a radius twice its diameter without cracking the coating. It is highly resistant to heat, most organic solvents, and offers excellent oil and fungus resistance. Tubing meets revised MIL-I-3190B specifications and Class H requirements. It is available in standard NEMA sizes in black and nine colors. Smaller sizes can be used in electronic chassis assemblies. **Bentley, Harris Mfg. Co.**, Conshohocken, Pa.

Circle 696 on Page 19

Filler Cap

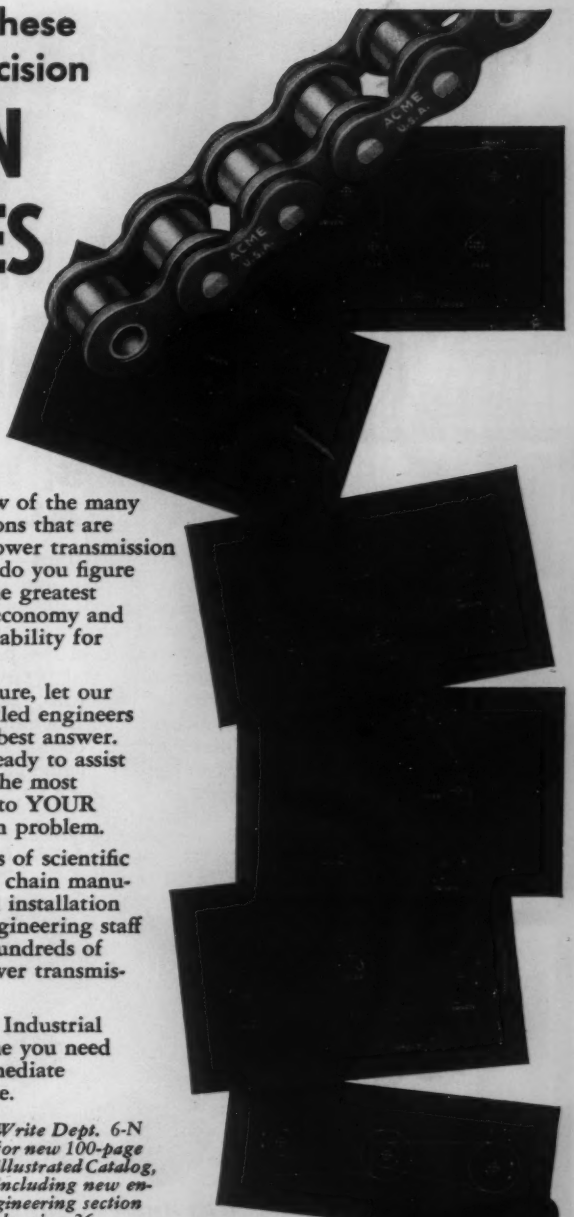
for equipment using liquids in closed containers



Which of these ACME Precision

CHAIN DRIVES

will help you drive it better?



Here are just a few of the many chain drive positions that are unsurpassed for power transmission efficiency. Which do you figure would give you the greatest efficiency, lowest economy and longer-life dependability for your application?

To be absolutely sure, let our staff of highly skilled engineers help you find the best answer. They are always ready to assist you in obtaining the most desirable solution to YOUR power transmission problem.

With over 30 years of scientific research, precision chain manufacturing skill and installation experience, our engineering staff has helped solve hundreds of tough-to-crack power transmission problems.

Contact your local Industrial Distributor anytime you need *"any"* kind of immediate Acme Chain service.

Write Dept. 6-N for new 100-page illustrated Catalog, including new engineering section showing 36 methods of chain adjustments.

Call ACME for Service

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HOLYOKE MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

Circle 514 on Page 19

Prevent

CORROSION DISTORTION

with

morganite

SELF-LUBRICATING

VALVES, SLIDES and SEAL NOSES

GASOLINE PUMP VANE

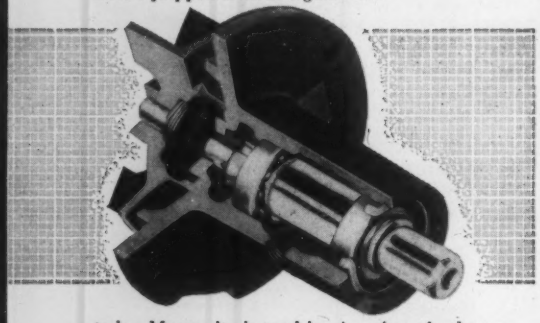
CRANE CURRENT COLLECTOR

DRUM CONTROLLER CONTACT

RADAR CONTACT

Eliminate failures—Due to swelling, warping, sticking and gumming. Morganite is chemically inert, imparts no taste, odor or colors—provides trouble-free operation in the presence of high temperatures and pressures, oil, water, corrosive chemicals, gases. Proven-in-service on food machinery, fuel pumps, liquid meters, compressors, enameling conveyors, jet engine pumps, pipe lines, process equipment.

Some of the first mechanical seal pumps using carbon seals, one of which is illustrated below, were equipped with Morganite...



...today Morganite is used in aircraft and other modern pumps for trouble-free operation.

Designers! Engineers!—Morganite solves complex lubricating problems. Ask for complete information on Morganite Self-Lubricating Bearings, Pump Vanes, Gland and Piston Rings and other components. Morganite engineers will make recommendations on request.

Morganite INCORPORATED

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...FOR OVER HALF A CENTURY

Manufacturers of Fine Carbon Graphite Products including Carbon Specialties, Motor and Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts
Distributors of 99.7% Pure Al_2O_3 Tubes and Crucibles

New Parts

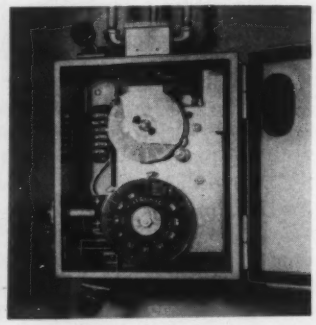
New filler cap is for use on fluid tanks, gear cases, engine crankcases, or other equipment using liquids in closed containers. It snaps open and closed, eliminating loose parts. Unit is available in combination with built-in breather vents and dip sticks. Cap of rugged, lightweight aluminum pressure die castings, meets requirements of industrial and automotive equipment. **Technical Development Co.**, 305 South Chester Pike, Glenolden, Pa.

Circle 697 on Page 19

Timing Device

for flexible cyclic control applications

Model IBC-2 integral button controller combines the features of a cam timer and an interval timer in one easily adjusted and maintained unit. Designed primarily for control of operations related



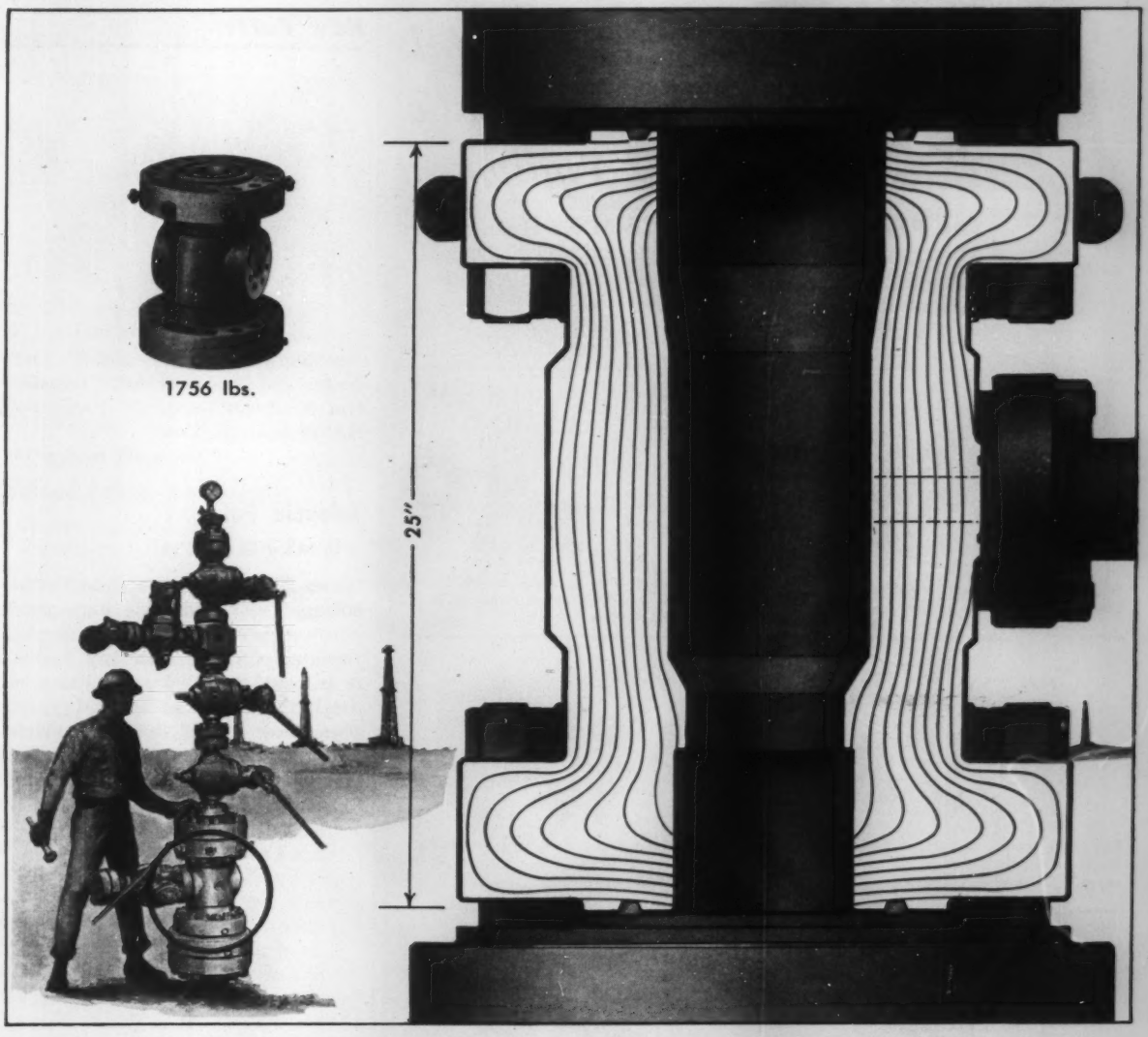
to the compression molding industries, it serves a wide field of flexible cycle-control applications without the use of relays. **Seely Instrument Co.**, 377 Fourth St., Niagara Falls, N. Y.

Circle 698 on Page 19

Clutches and Brakes

have diameters from 4 to 12 in.

Line of electric clutches and brakes consists of five styles in six sizes from 4 to 12 in. in diam, with torque outputs from 10 oz-in. to 450 lb-ft. They are of single-friction type, free of sliding parts. Torque output is controlled through electrical circuits. Five types include clutch coupling, electric clutch, simple electric brake,



SPLIT-DIE STEEL FORGING SOLUTION FOR 15,000 PSI CHRISTMAS TREE PROBLEM

This tubing head spool for oilfield Christmas Trees is still another example of the superiority of Cameron's split-die steel forgings. Thousands of these critical components are on the job almost everywhere oil is produced. The model above must first withstand 22,500 psi test pressure to operate safely at 15,000 psi working pressure — but this is only the beginning. When set, it must be able to support in excess of 300,000 lbs. of heavy steel tubing suspended miles below the earth's surface.

The exclusive Cameron split-die forging process produces two important advantages — 1) Shapes impossible to produce by any other forging method, and 2) Grain flow to meet the most extreme performance demands. The inherent forging advantage of great strength with less mass has been extended to include a new design range. Open center sections, curved or flat surfaces in almost endless variety and odd protrusions are routine design elements when Cameron split-die forgings are specified. These vastly superior ferrous parts are forged to 8,000 lbs. weight.

Cameron is busy today producing split-die forged steel parts for jet engines, guided missiles, atomic reactors and, of course, Cameron Christmas Trees.

Our complete production facilities, from melting of high quality alloy steels to finished machining if desired, allows undivided responsibility — that's another reason why we are serving more customers every month. If you are using castings where forging quality is desired, or if conventional forgings are inadequate, write, call or come by—

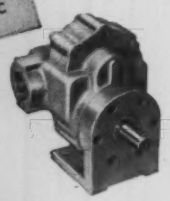
IRON WORKS, Inc.
P. O. Box 1212, Houston, Texas
SPECIAL PRODUCTS DEPARTMENT

Circle 516 on Page 19

ADEL *Industrial Hydraulic Equipment*

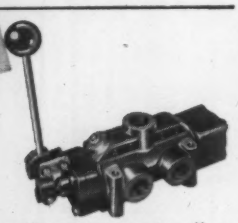
for PEAK PERFORMANCE ADEL Hydraulic Valves and Pumps are setting new and ever higher standards for precision in manufacturing and efficient performance in operation. Following are but a few of the wide variety of models to meet all operating conditions.

GEAR-TYPE HYDRAULIC PUMPS



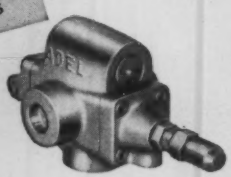
For 1000 psi service with rated capacities at 1800 rpm of from 1.5 to 46.8 gpm.

DIRECTIONAL CONTROL VALVES



4-way valves with spring-centered, spring-offset, and 1, 2, or 3 position detent action. 1500 psi. Flows to 28 gpm.

BY-PASS VALVES

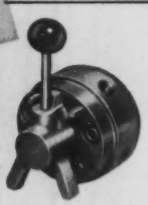


Relief, Sequence and Unloading valves. Direct or remote operation, 50 to 1500 psi range.

VOLUME (FLOW) CONTROL VALVES

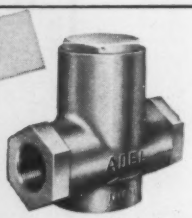
Compensated type maintains constant flow over wide differential pressure range. No drain line required. 1500 psi.

PILOT VALVES



2 or 3 position detent. With or without dog or lever. Can be used as 4-way valve in small circuits. 1000 psi.

CHECK VALVES



Valves allow free flow in one direction only. Many variations available. 3000 psi.

Reliability
ADEL PRECISION PRODUCTS
A DIVISION OF GENERAL METALS CORPORATION

BURBANK, CALIFORNIA • HUNTINGTON, WEST VIRGINIA

Manufacturers of | MARINE & INDUSTRIAL HYDRAULIC CONTROL EQUIPMENT

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Robert Taylor & Sons
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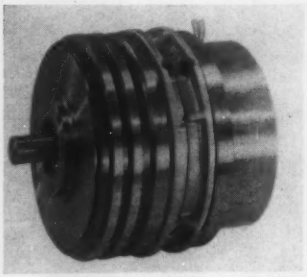
WASHINGTON
Russ Chamberlin Company
Seattle, Washington

New Parts



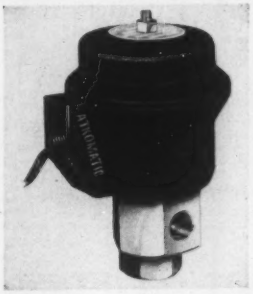
combination electric clutch and brake, and duplex clutch. **Simplatrol Products Corp.,** 24 Salisbury St., Worcester, Mass.

Circle 699 on Page 19

Solenoid Valve

is rated to 6000 psi

Series 2000 two-way, stainless-steel solenoid valve controls high-pressure corrosive gases and fluids. Designed for use with any media, it is rated to 6000 psi. Valve is available in ⅛, ¼, ⅜, and ½-in. pipe sizes. Port sizes depend on maximum pressures and viscosity of media. Teflon or nylon seats,



explosionproof housing, and bubble-tight construction are optional. **Atkomatic Valve Co. Inc.,** 545 W. Abbott St., Indianapolis 25, Ind.

Circle 700 on Page 19

Fasteners

lightweight units have built-in torque control

Hi-Lok fasteners combine the advantages of a nut and bolt with those of a rivet. Interchangeable with all high-strength fasteners, they are installed with standard hand or power tools and are easily removed. Hi-Lok can be reused. Built-in torque control provides controlled preload, consistent in each fastener. Light, the fasteners

are available in a variety of material combinations for high-strength and high-temperature applications. **Hi-Shear Rivet Tool Co.**, 2600 W. 247th St., Torrance, Calif.

Circle 701 on Page 19

Silicone Rubber Compound

fusible material is for general-purpose insulating

K-1605R fusible silicone rubber compound is a general-purpose insulating type which conducts electricity and has excellent resistance to reversion. It can be made into insulating tapes which adhere on contact when wrapped on themselves, as in the construction of an electrical cable. Tapes can be unsupported, or supported by glass fibers or other synthetic fabrics, or by other rubbers. Compound can also be extruded, calendered, or molded into a variety of other shapes. The fusible compound gives excellent bonds to metals and fabrics. Silicones Div., **Union Carbide Corp.**, 30 E. 42nd St., New York 17, N. Y.

Circle 702 on Page 19

Spherical Bearings

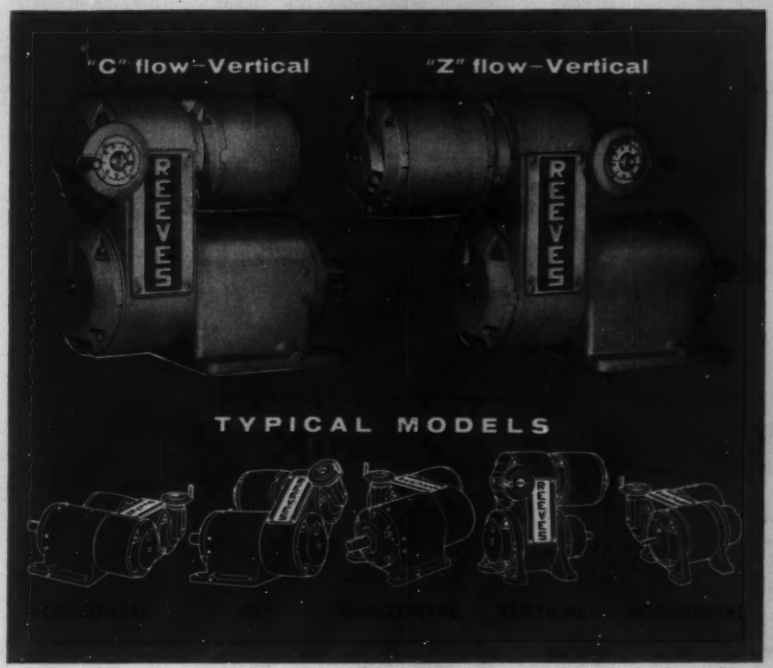
in static-load capacities from 4800 to 93,500 lb

COR corrosion-resistant spherical bearings consist of a heat-treated, stainless-steel outer race and heat-treated, stainless-steel, hardened and hard chrome-plated ball. They are available in eleven sizes with

NEW **REEVES**®

*Sizes 200-300 Vari-Speed MOTODRIVES**

**200-300 Size, 1 through 5 hp.; full line, ¼ through 40 hp.*



The flexible design of these compact new REEVES variable speed power packages permits hundreds of combinations . . . space-saving, space-fitting *standard* assemblies to meet most installation requirements. All models are available in both "C" flow and "Z" flow styles.

New increased capacity is built in the reducers—single, double or triple stages . . . new disc assemblies permit wider output speed ranges . . . discs are pre-aligned . . . pre-loaded spring maintains correct belt tension for longer belt wear . . . *exclusive* "close-grooving" lubrication assures free sliding discs . . . new Metermatic system automatically lubricates the motor and variable shaft bearings.

Complete information on all phases of the versatile 200-300 sizes Vari-Speed Motodrives is given in new Catalog. Write for your free copy today—Dept. H32b-M571.

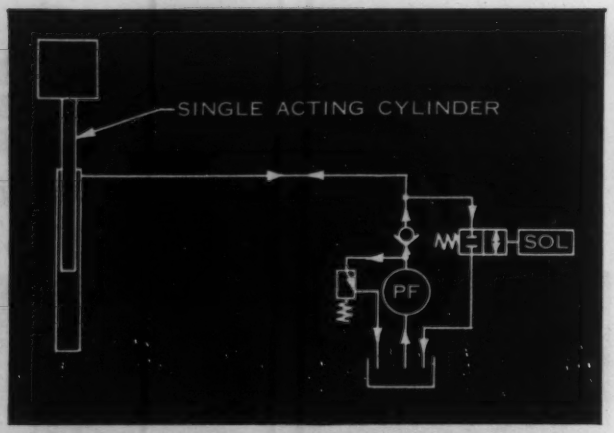
REEVES PULLEY COMPANY

Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

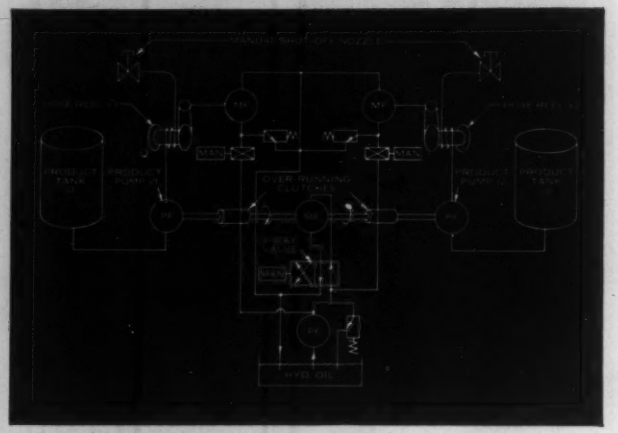
Columbus, Indiana

Circle 518 on Page 19

SIMPLE CIRCUIT



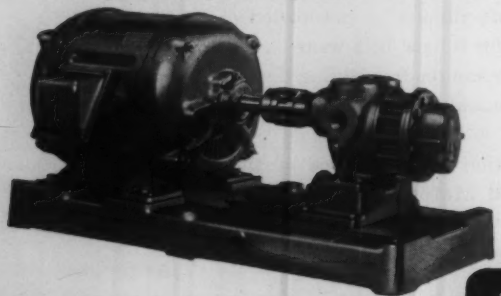
COMPLEX CIRCUIT



ROPER

Serves Both Best

The key to any hydraulic system is the pump. It must have the proper characteristics in relation to the other equipment in the circuit — whether simple or complex. It must also be *dependable* and have the *stamina* to provide long and trouble-free service. Roper Rotary Pumps *have* the attributes that are so necessary to effect optimum performance, and you can count on them for successful control of circuits involving either tons or pounds. On your next hydraulic problem, investigate Roper Rotary Pumps. Find out how they can be the key to a dependable hydraulic system.



PUMPS TO 1000 P.S.I.

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HYDRAULIC PUMP-MOTORS

High Torque Low Speed
Up to 11.5 H.P. output

ROPER HYDRAULICS, INC.
formerly
Geo. D. Roper Corporation, Pump Division
251 Blackhawk Park Ave.
Rockford, Illinois

ROPER
Rotary Pumps

Circle 519 on Page 19

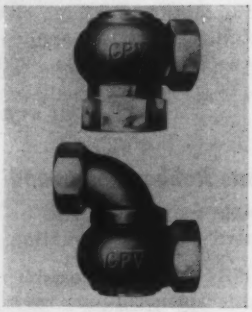
New Parts

static-load capacities from 4800 to 93,500 lb. **Sealmaster Bearing Div.,** Stephens-Adamson Mfg. Co., Ridgeway Avenue, Aurora, Ill.

Circle 703 on Page 19

Swing Joint

for machine tool coolant lines



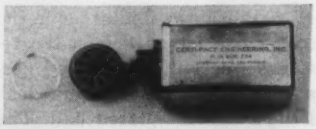
Free-swinging, nonleaking swing joint conducts coolants to the working areas of machine tools. Joints are available in in-line and angle types in four sizes from ⅜ to 1 in. Bodies are cast bronze. **Combination Pump Valve Co.,** 849 Preston St., Philadelphia 4, Pa.

Circle 704 on Page 19

Coincidence Relay

monitors three external circuits

The opening of any two of three circuits monitored by the Model CR-1 coincidence relay de-energizes the unit. Monitoring three external normally closed signal or alarm circuits, relay resets only when all three circuits are normal or in the closed position. Unit is plug



mounted, and is enclosed in a dust-resistant, plated metal housing. Mating 11-pin, octal-style socket is provided with each relay. Unit operates at 115 v dc, continuous duty. Contacts are double pole, double throw. Relay is 1⅞ x 2 x 3⅛ in. high. **Certi-Fact Engineering Inc.,** P. O. Box 774, Sherman Oaks, Calif.

Circle 705 on Page 19

Master B-100 Portable Space Heater
MANUFACTURED BY MASTER VIBRATOR COMPANY DAYTON, OHIO

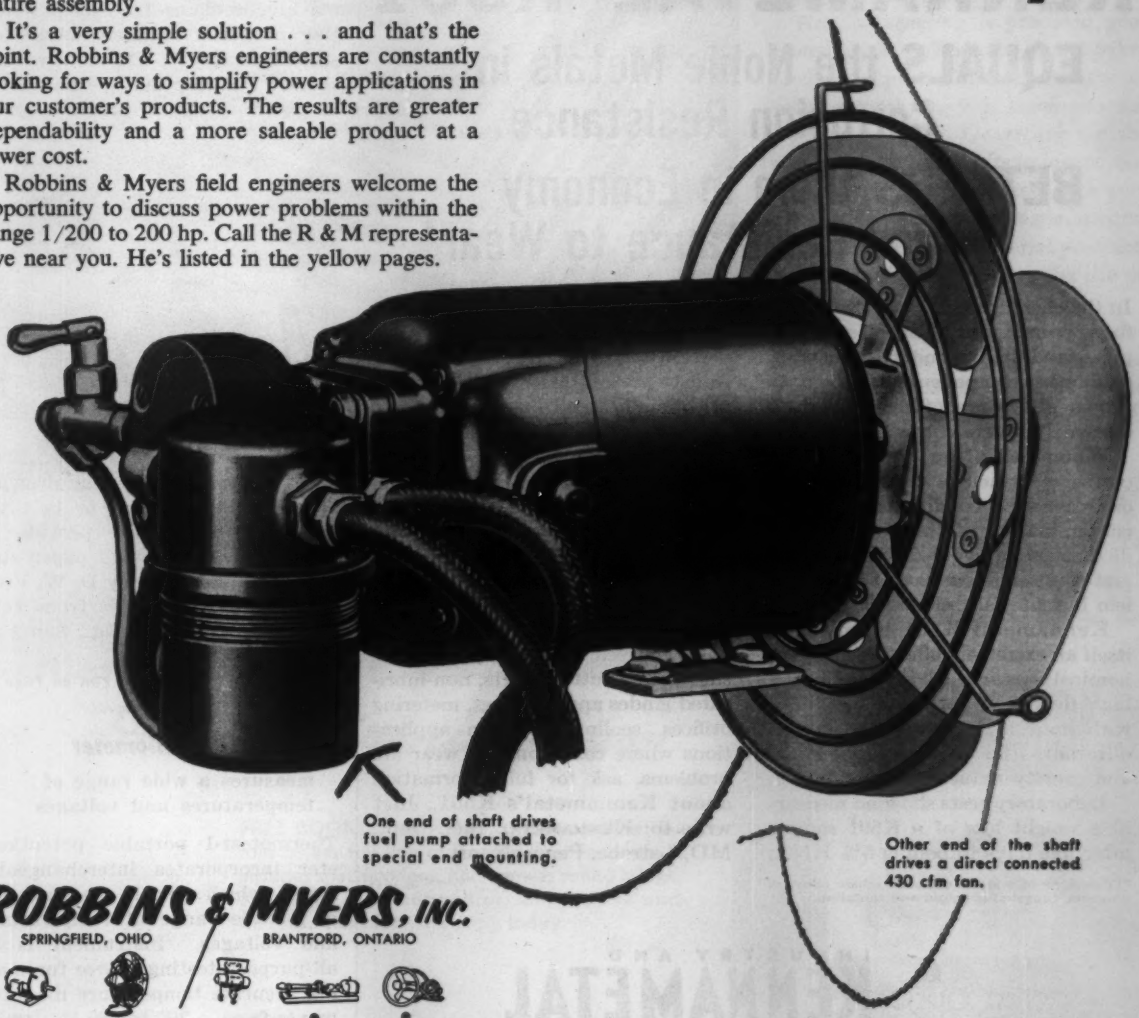
R&M motor does double duty

To accomplish compactness, simplicity and lower cost, this enclosed ¼ hp., 3450 rpm split phase Robbins & Myers motor was specially designed to do two important jobs in the Master B-100 Portable Space Heater.

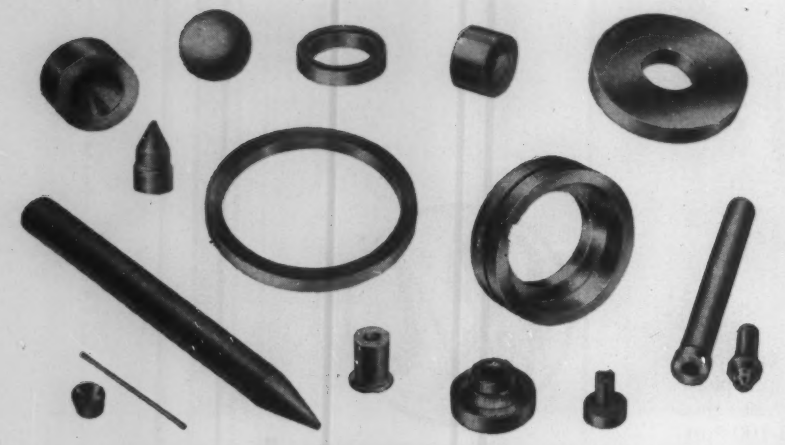
A special face mounting accommodates a direct driven fuel pump. The other end of the shaft drives a direct connected fan with an output of 430 cfm. A rigid foot mounting on the motor supports the entire assembly.

It's a very simple solution . . . and that's the point. Robbins & Myers engineers are constantly looking for ways to simplify power applications in our customer's products. The results are greater dependability and a more saleable product at a lower cost.

Robbins & Myers field engineers welcome the opportunity to discuss power problems within the range 1/200 to 200 hp. Call the R & M representative near you. He's listed in the yellow pages.


One end of shaft drives fuel pump attached to special end mounting.
Other end of the shaft drives a direct connected 430 cfm fan.

ROBBINS & MYERS, INC.
SPRINGFIELD, OHIO BRANTFORD, ONTARIO



In parts like these

KENNAMETAL* K501

EQUALS the Noble Metals in Corrosion Resistance...

BETTERS them in Economy and Resistance to Wear!

In the chemical field, and also in the food, paint, petroleum, oil refining, paper and atomic energy industries, equipment components like the ones shown above are often exposed to extremely severe corrosion.

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Laboratory tests show no measurable weight loss of a K501 sample after five days in boiling 5% HNO_3 and 5% H_2SO_4. Loss was only 74/mg/dm/day in boiling 5% HCl.

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If you have use for valve parts, balls and seats, guides, wear rails, slitting and cutting parts, non-lubricated guides and bushings, metering orifices, sealing rings, in applications where corrosion and wear are problems, ask for full information about Kennametal's K501. Just write to: KENNAMETAL INC., Dept. MD, Latrobe, Pennsylvania.

*Trademark of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum.

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ENGINEERING DEPARTMENT

EQUIPMENT

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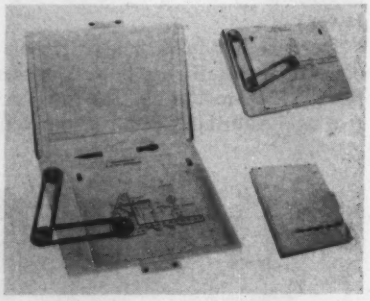

Circle 706 on Page 19

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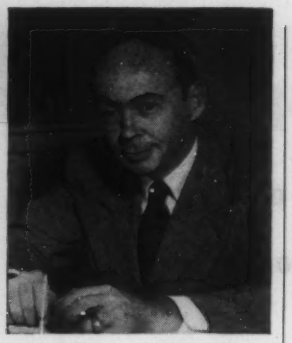
MICRO-BEARING ABSTRACTS

by **A. N. DANIELS**, *President*
New Hampshire Ball Bearings, Inc.



CONTACT ANGLE

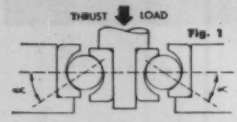


Fig. 1

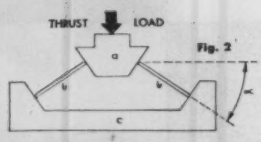


Fig. 2

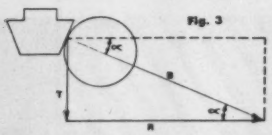


Fig. 3

Contact angle is the angle between a plane perpendicular to the bearing axis and a line connecting the two points on a given ball where the ball makes contact with the raceways when the bearing is subjected to a pure thrust load. In *Fig. 1*, the contact angle is represented by angle α. The significance of the contact angle is revealed by an examination of the forces present in a thrust loaded bearing.

In *Fig. 2*, a simplified version of *Fig. 1*, the shaft and inner ring combination are represented by the plug *a*, the "working diameters" of the balls and represented by the rodlike members at *b*, and the outer ring is represented by the tapered cup *c*.

The contact angle is α. This diagram represents a three-dimensional structure with as many equally spaced rods, *b*, as there are balls in the bearing.

The primary concern in design is the amount of compressive force to which rod *b* is subject, which is the force with which a given ball is pressed against the raceways. This force can be calculated by constructing a parallelogram of forces as shown in *Fig. 3*.

The sides T and R, are vector quantities, and diagonal B is the vector sum of T and R. Furthermore, the vector sum of the thrust components on all the balls equals the total thrust load on the bearing. The vector sum of the radial components on all the balls is zero. Vector B, the force actually felt by the raceways and balls, compared to vector T, the thrust component, varies significantly with changes in the size of the contact angle and is directly proportional to the thrust load component and inversely proportional to the sine of the contact angle.

Example I:

A bearing is carrying a pure thrust load of 21 pounds. Assuming seven balls in the bearing, each ball will have an axial load component of three pounds, since a thrust load is shared equally by all the balls. While the axial component on each ball is only three pounds, the actual compressive force, or squeeze, felt by the ball and raceways is considerably greater than this value.

With a contact angle of five degrees:

$$B = \frac{T}{\sin \alpha} = \frac{3 \text{ lbs.}}{\sin 5^\circ} = 34.5 \text{ lbs.}$$

Thus we see that with a five-degree contact angle the actual load felt by each individual ball is actually considerably greater than the total 21 pound thrust load on the bearing.

Example II:

Using the thrust conditions in Example 1, the contact angle is increased to 20 degrees, by selecting a bearing with a larger value of radial play.

$$B = \frac{3 \text{ pounds}}{\sin 20^\circ} = 8.78 \text{ pounds}$$

A 15 degree increase in contact angle produced a 74.5% reduction in ball-to-raceway contact stress. This relationship should be noted by anyone who writes bearing specifications. The operational qualities of the bearing, such as low running and starting torque and bearing life, are a function of the ball-to-raceway contact stress. Thus the contact angle is highly significant.

It is not necessary for a bearing user to calculate or specify the contact angle desired. It is only necessary to remember that low values of contact angle are associated with low radial play, and high values of contact angle are associated with high radial play. In addition to the above considerations, gyratory forces become extremely important factors in determining optimum contact angle in high speed applications.

A more complete discussion of contact angle is found in our design handbook.

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If you work with miniature bearings, you'll find this new, 70-page authoritative publication a great help in solving problems in designing instruments or small electro-mechanical assemblies.

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NEW HAMPSHIRE BALL BEARINGS, INC., PETERBOROUGH 1, NEW HAMPSHIRE
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Engineering Equipment

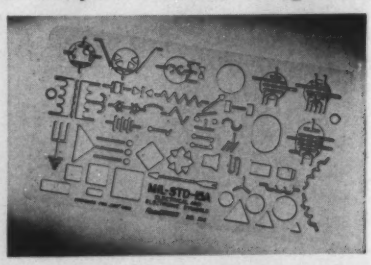
mv. Four aluminum disc scales are included, three for temperatures and one for millivolts. Parallax-corrected magnifying viewer permits accurate readings of slight variations. Unit has a mercury battery power supply. **Technique Associates Inc.**, P. O. Box 91, Indianapolis, Ind.

Circle 707 on Page 19

Template

for drafting of electrical components

No. 314 MIL-STD-15A electrical and electronic symbols template is 0.040 mathematical quality plastic designed for 0.200-in. grid paper. Template is precision milled with bevel cut for accurate depiction of latest symbols embodied in govern-



ment drafting requirements for electrical components. Overall size of the template is 7 x 4 in. **Rapidesign Inc.**, P. O. Box 429, Burbank, Calif.

Circle 708 on Page 19

Vibration Pickup

operates continuously from −65 to 500 F

Developed for ground and in-flight monitoring of jet engines, Type 4-120 vibration pickup can be used in all high-frequency, low-amplitude vibration studies under extremes of temperature. It operates continuously from −65 to

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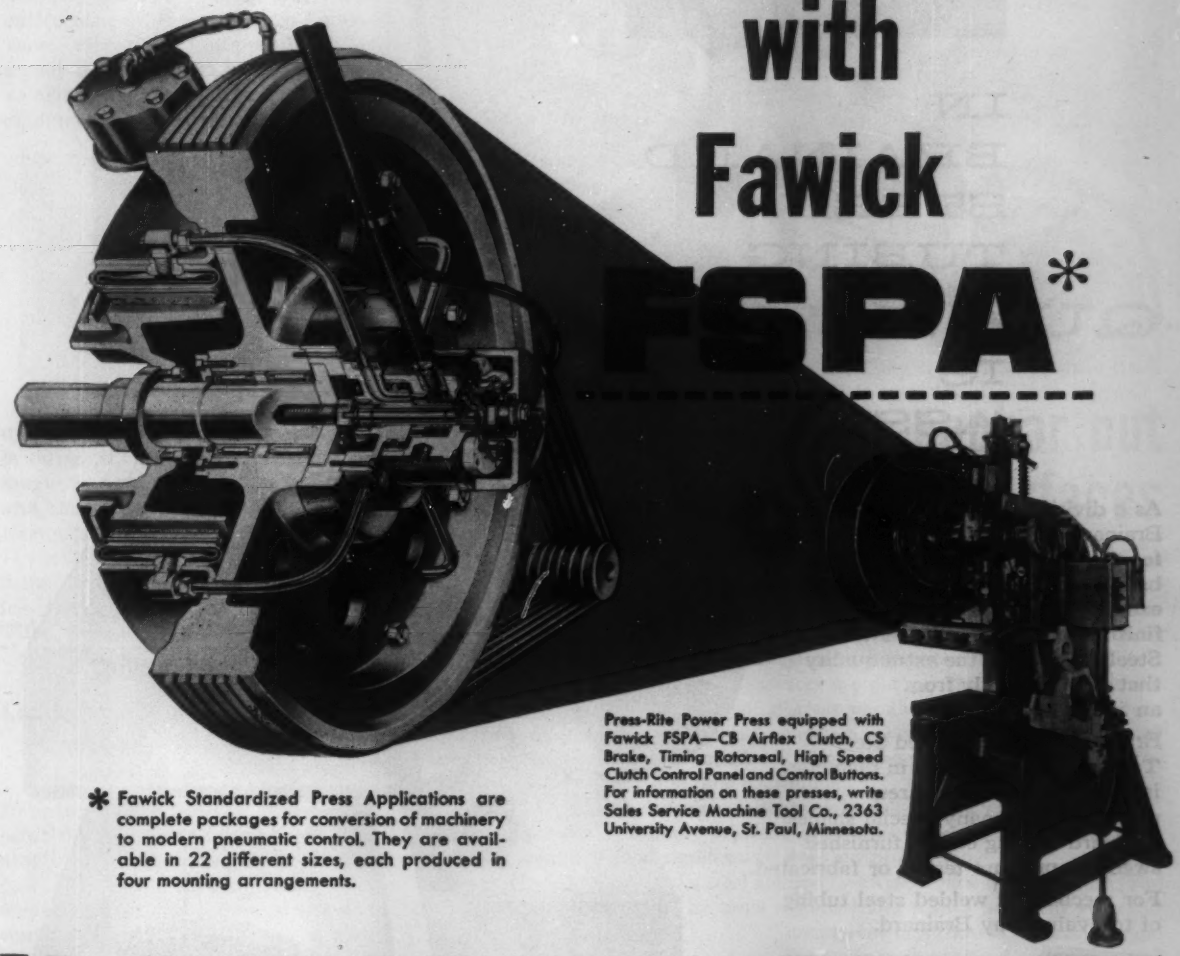

Press-Rite Power Press equipped with Fawick FSPA—CB Airflex Clutch, CS Brake, Timing Rotorseal, High Speed Clutch Control Panel and Control Buttons. For information on these presses, write Sales Service Machine Tool Co., 2363 University Avenue, St. Paul, Minnesota.

* Fawick Standardized Press Applications are complete packages for conversion of machinery to modern pneumatic control. They are available in 22 different sizes, each produced in four mounting arrangements.

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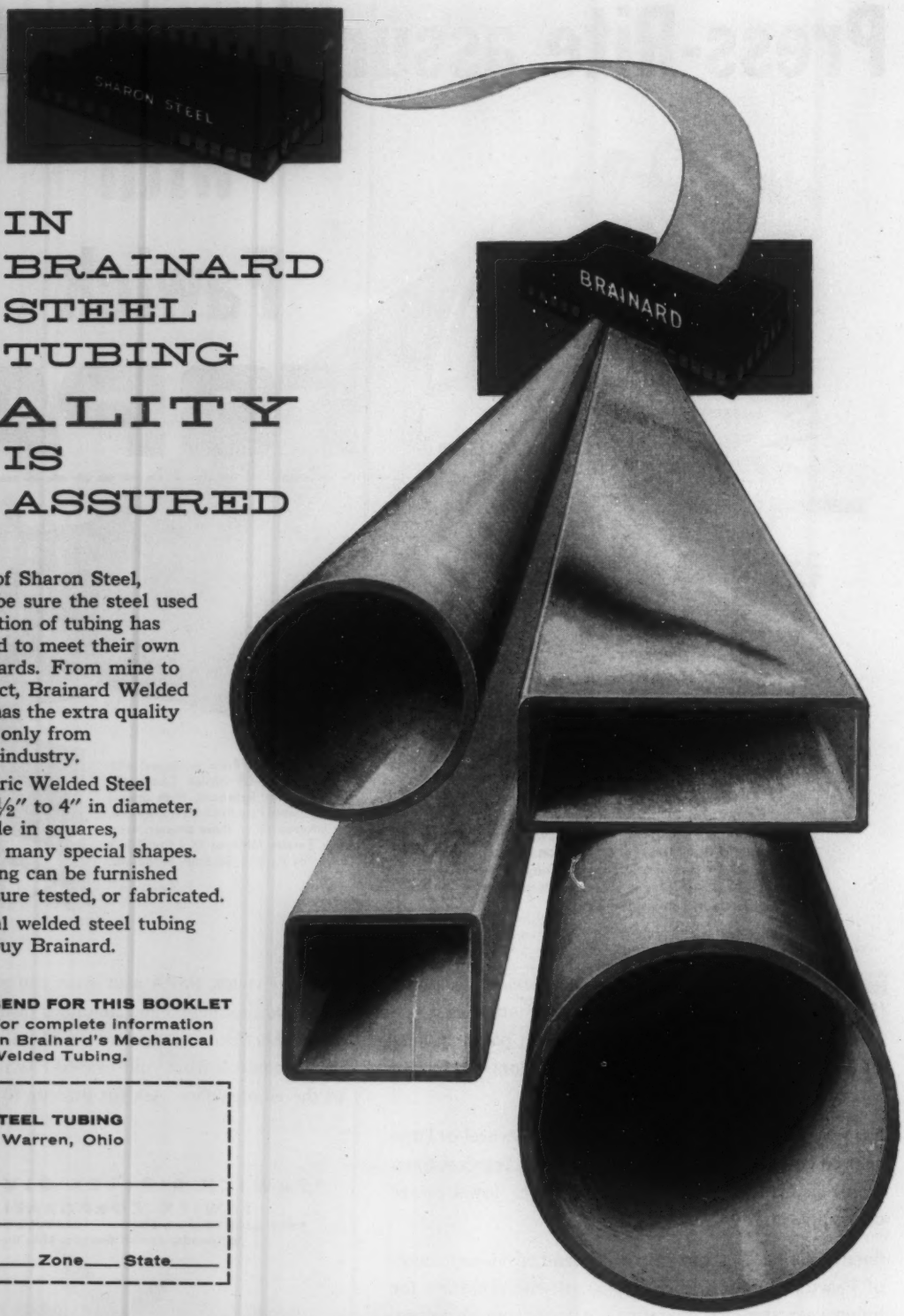

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Circle 525 on Page 19

500 F, and has a frequency range of 40 to 2000 cps with linearity of ±4 per cent of reading over the entire range. Insensitive to transverse vibration, unit produces a signal directly proportional to the velocity, as low as the recording equipment will measure. Maxi-

mum acceleration without damage is 50 g. Pickup incorporates two magnets, one to control sensitivity and the other to control damping. Hermetically sealed unit measures 1¼ x 2¾ in. and weighs less than 5 oz. **Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.**

Circle 709 on Page 19

Computer Kit

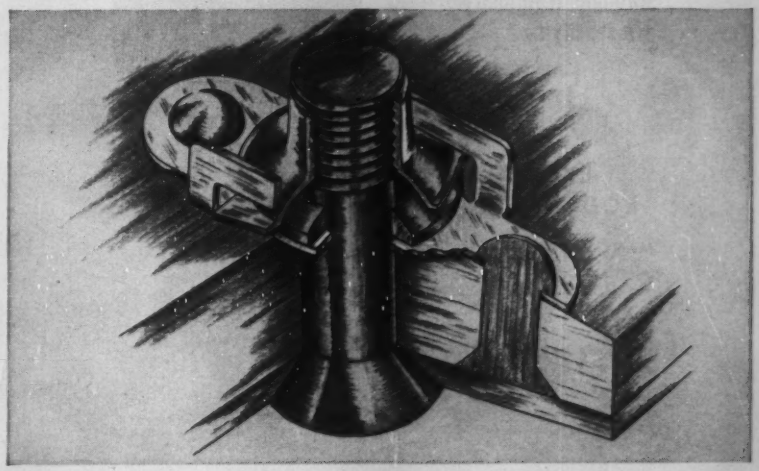
for design of computers and control systems

Mounting chassis, an 18-contact printed-board connector, holds 15 plug-in, transistorized printed-circuit cards of digital system elements. Cards use different circuit configurations, and can be combined to meet a variety of com-

puter and control applications. Cards are 6 x 3 13/16 in. in size. Illustrated is a typical card, the FF-3 flip-flop. **Comptron Corp., 778 Pleasant St., Belmont 79, Mass.**

Circle 710 on Page 19

FASTENER PROBLEM

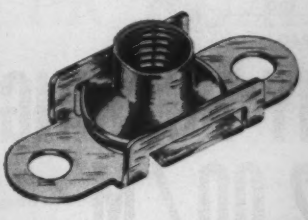


Lightweight floating anchor nut for bolting non-parallel surfaces

THE PROBLEM: Using large single forgings for aircraft bulkheads, wing center sections, spars and ribs offers manufacturers many advantages. It simplifies design and reduces milling costs, and it provides greater strength while reducing air frame weight. However, this type of construction also creates fastening problems. For example, attaching skins and components to these tapered forgings is difficult because the bolt head and seating surfaces are not parallel. Two methods are frequently used to make the fastening areas parallel. They are: 1) spot face machine the seating surfaces, 2) build up each bolt head or nut base with tapered shims. Because there are often hundreds of fastening points, both of these methods are excessively costly and time consuming.

THE SOLUTION: ESNA's redesigned lightweight self-locking anchor nut (Type LHA3022) solves this fastener problem, eliminates these costly, shimming and machining operations and significantly steps up production.

Type LHA3022 consists of a steel nut body with a concave spherical base. The convex seat permits the nut to move automatically with a ball joint action to engage the bolt threads. Two lugs retain the nut in the basket and control the "tilt" to 8° in any direction.



Type LHA3022 is made of carbon steel for use at temperatures up to 550°F. It meets AN-N-10 performance and MIL-N-25027 (ASG) twist- and push-out specifications. Like all Elastic Stop® nuts, it is vibration proof and reusable.

MAIL COUPON FOR DESIGN INFORMATION

Elastic Stop Nut Corporation of America, Dept. N28-114.
2330 Vauxhall Road, Union, New Jersey

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☐ Bulletin on self-aligning nut ☐ Here is a drawing of our product. What self-locking fastener would you suggest?

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Circle 526 on Page 19

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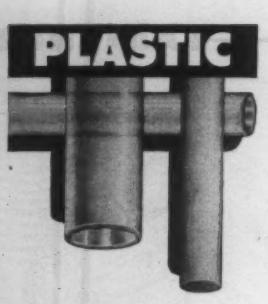

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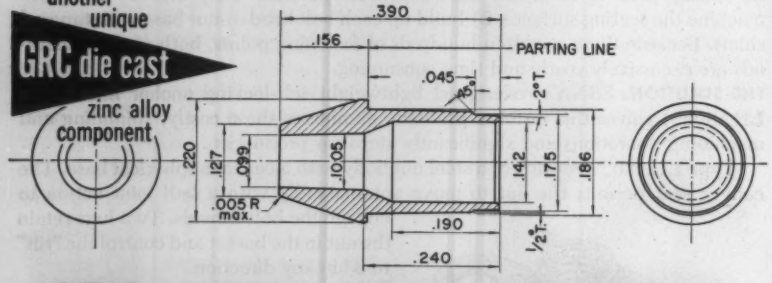

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Recent Books

Design of Steel Structures. *By Edwin H. Gaylord Jr. and Charles N. Gaylord;* 540 *pages,* 6 *by* 9 *in., cloth-bound; published by McGraw-Hill Book Co. Inc.,* 330 *West* 42*nd St., New York* 36, *N. Y.; available from* MACHINE DESIGN, $8.00 *postpaid.*

This book emphasizes the basic philosophy of structural design relative to design loads on steel and aluminum joints. Included are discussions on welded, riveted, and bolted connections. Each topic is introduced with relevant theory and reference to experimental evidence. Relation of theory and tests to standard design specifications is also emphasized.

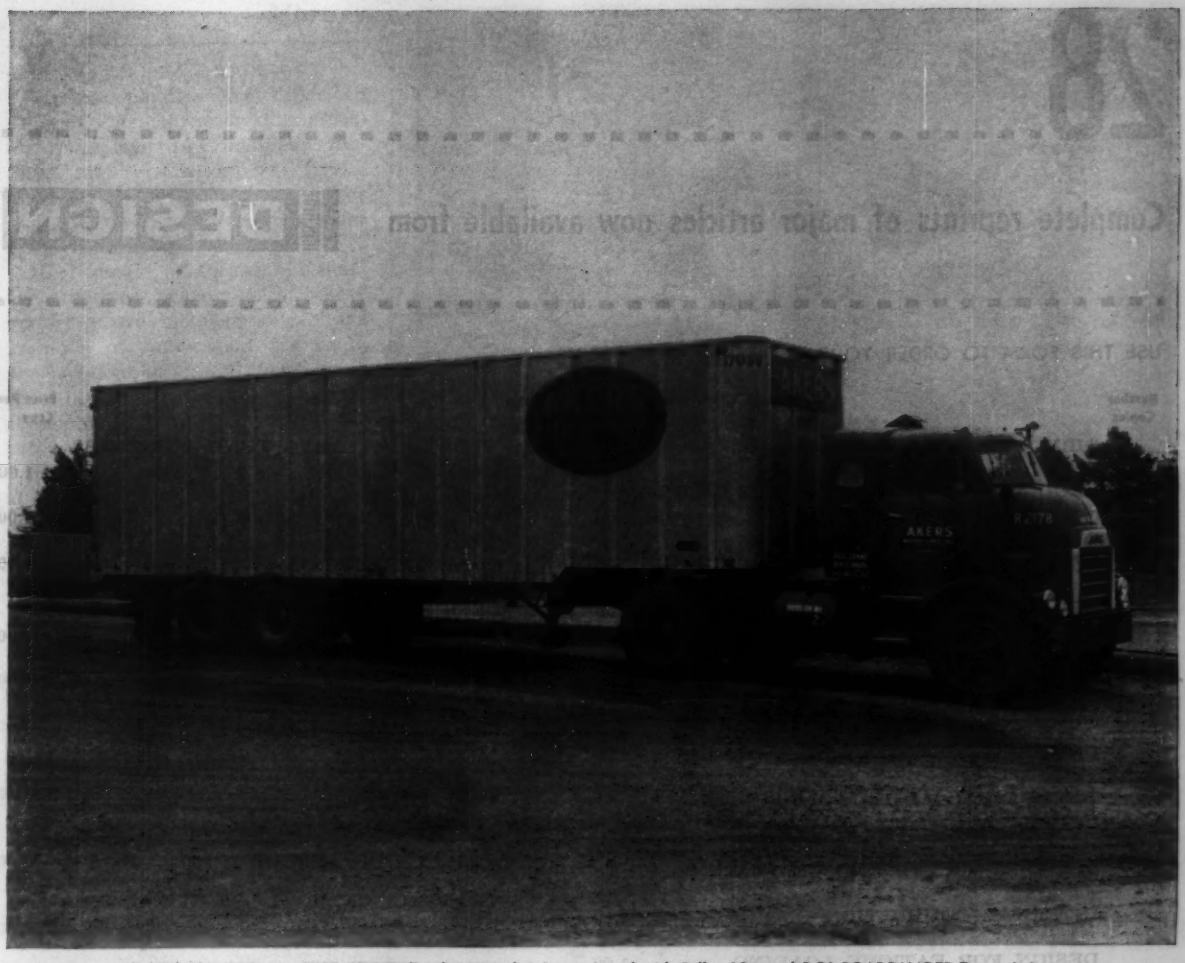
A special chapter on plastic design, or application of theories of ultimate strength, evaluates the elastic theory as a basis for design problems.

Applications of Fluid Mechanics. *By E. A. Bunt, University of the Witwatersrand, Johannesburg, South Africa;* 346 *pages,* 8½ *by* 11 *in., cloth-bound; published by and available from Witwatersrand University Press, Milner Park, Johannesburg, South Africa,* $6.00 *per copy plus postage.*

A thorough treatment of elementary fluid mechanics is included in this compilation of notes and lecture material presented at the University of the Witwatersrand.

Major topics include properties of fluids, dimensional analysis, systems of units, instrumentation, energy theorem, viscous flow, elements of hydraulic systems, turbine performance, rotodynamic machinery, and hydrodynamics of compressible flow.

Engineering Properties and Applications of Plastics. *By Gilbert Ford Kinney;* 278 *pages,* 6 *by* 9 *in., cloth-bound; published by John Wiley & Sons Inc.,* 440 *Fourth Ave., New York* 16, *N. Y.; available from* MACHINE DESIGN, $6.75 *postpaid.*



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Library

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Major topics include the general nature of plastics, polyethylene, polyvinyl chloride, polystyrene, acrylic plastics, cellulose plastics, phenolic plastics, silicones, and rubbers.

Dynamics of Machinery. *By James B. Hartman, Professor of Mechanical Engineering, Lehigh University;* 283 *pages,* 6 *by* 9 *in., clothbound; published by McGraw-Hill Book Co. Inc.,* 330 *West* 42*nd St., New York* 36, *N. Y.; available from* MACHINE DESIGN, $7.50 *postpaid.*

This book emphasizes development of fundamental principles of dynamics and their application to engineering problems.

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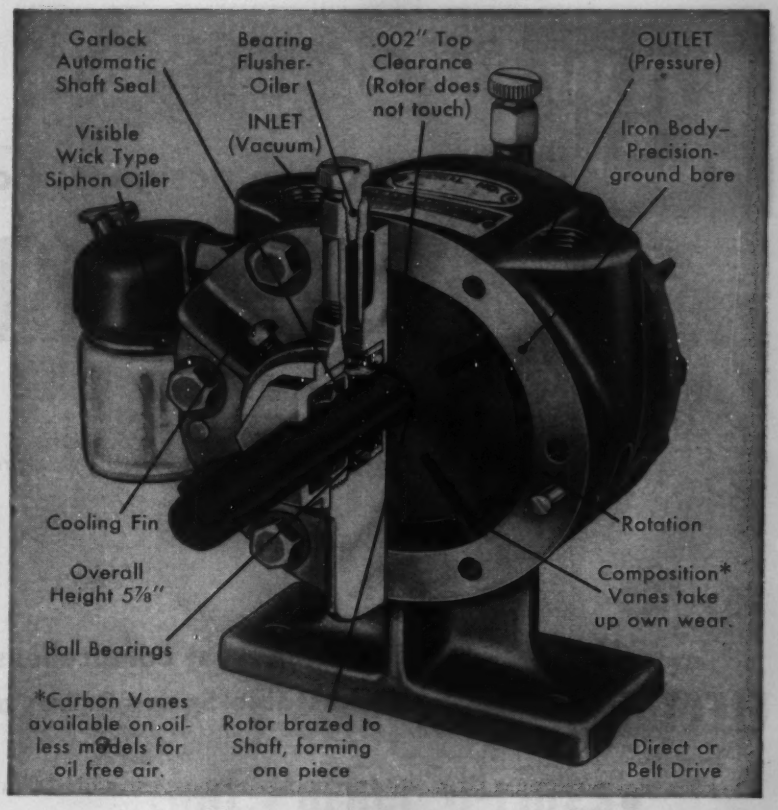
New Standards

American Drafting Standards Manual, *Sections* 1, 2, 4, *and* 5. *Each section is* 8½ *by* 11 *in., stapled and paperbound; available from The American Society of Mechanical Engineers, Order Dept.,* 29 *West* 39*th St., New York* 18, *N. Y.*

Section 1, ASA Y14.1—1957—Size and Format; 11 *pages,* $1.00

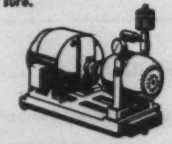

Garlock Automatic Shaft Seal
Visible Wick Type Siphon Oiler
Bearing Flusher-Oiler
INLET (Vacuum)
.002" Top Clearance (Rotor does not touch)
OUTLET (Pressure)
Iron Body–Precision-ground bore
Cooling Fin
Overall Height 5⅞"
Ball Bearings
*Carbon Vanes available on oil-less models for oil free air.
Rotor brazed to Shaft, forming one piece
Rotation
Composition* Vanes take up own wear.
Direct or Belt Drive

rotary vane

Quality and simplicity keep GAST AIR PUMPS operating for years at high efficiency levels

INTEGRAL-MOTOR PUMPS 1/12 to 1/3 H.P. .6 to 4 CFM. to 28" VAC., to 25 PSI.

LIGHT-DUTY PUMPS, V-belt or direct drive. 2 to 24 CFM. Moderate vacuum or pressure.



HEAVY-DUTY PUMPS, 1/4 to 1-1/2 H.P. 4 to 21 CFM. To 28" VAC. or 30 PSI. Cooling fans and fins.

As original components—or for special plant use—Gast Air Pumps offer important advantages. This cutaway reveals many reasons why they are specified as "original equipment" by more and more leading manufacturers.

All models are built to high quality-precision standards in a new, modern plant. All embody this inherently efficient, simple rotary-vane design. Balanced rotor is free of vibration. Sliding vanes are light in weight—for minimum motion-energy-friction loss compared to other pump designs. As vanes take up their own wear automatically, pump delivers full performance through years of use.

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Original Equipment Manufacturers for Over 25 Years

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- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

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Here, in *one* book—148 pages, with 24 tables, 119 charts and 171 illustrations—is what the designer should know about adjustable speed. It contains the entire co-ordinated program of articles which appeared in MACHINE DESIGN on main drive and transmission types—electric-motor, slip-coupling methods, mechanical drives, and hydraulic drives.

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Remittance or Company Purchase Order must be enclosed with order.

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per copy. Contents of this section concern basic sheet sizes and arrangement of format data. Included are definitions of sizes, block size, title block location and content, revision block location and content, material lists, drawing numbers, and numbering of multiple sheets.

Section 2, ASA Y14.2—1957—Line Conventions, Sectioning, and Lettering; 19 *pages*, $1.50 *per copy*. This section presents standards of conventional line thicknesses recommended for use on drawings. Numerous examples of special applications are shown. Other topics are sectioning and sectioning symbols, cutting planes, half and full sections, auxiliary sections, and intersections.

Section 4, ASA Y14.4—1957—Pictorial Drawing; 16 *pages*, $1.50 *per copy*. This standard has been prepared for the purpose of defining and illustrating various kinds of pictorial drawings with such information as may be necessary in the use of these drawings in industry. Treatment includes axonometric, isometric, dimetric, and trimetric projections. Pictorial plane dimensioning, catalog illustrations, and exploded views are also included.

Section 5, ASA Y.14.5—1957—Dimensioning and Notes; 39 *pages*, $2.00 *per copy*. This section deals with rules, principles, and methods used in specifying design requirements on mechanical drawings by means of dimensions and notes. Its purpose is to establish uniform practices of stating and interpreting these requirements.

These sections, together with others yet to be approved, will comprise the American Drafting Standards Manual but will be published separately by ASME.

Government Publications

Wright Air Development Center Technical Reports. *Each publication is 8¼ by 10¾ in., paperbound, and stapled; copies are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

Prove by comparison tests that Parker O-rings seal better, last longer

Comparison tests will prove it. You can't *see* the difference. You can't *feel* it. But in *use*, Parker O-rings seal better, last longer.

Why? Because Parker O-rings are precision-molded of superior compounds developed by exhaustive research and experimentation. From Parker, you get the *right* O-ring for your *specific* application.

These trouble-free, leakproof seals are carefully evaluated for elongation, tensile strength, compression set ratings, resistance to oils, fuels, chemicals and temperature extremes. Whatever your requirements, Parker can supply the O-rings you need.

Parker O-Lube is especially formulated for lubrication requirements.

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17325 Euclid Avenue, Cleveland 12, Ohio.
1538 South Eastern Ave., Los Angeles, Cal.

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☐ O-Lube Catalog No. 5840

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ADDRESS _____
CITY _____ STATE _____

PARKER RUBBER DIVISION

Parker Hannifin
creative leader in fluid systems

Circle 531 on Page 19

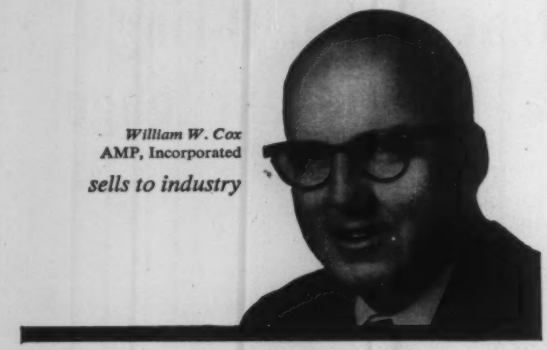
Can specialized business publication advertising actually sell?

By reputation, salesmen are reluctant to credit anything but their own selling efforts for getting names on the dotted line.

Actually, it's quite a different story. The most successful salesmen will tell you two important things about selling. 1. That the selling process is largely a matter of communicating ideas. 2. And that specialized business publication advertising can help importantly to register information with prospects.

Of course each salesman will express this in his own way ... but they all agree that selling would be far more difficult without the advertising that appears in the industrial, trade, and professional publications that serve the specialized markets to which they sell.

Here, for instance, is what a salesman has to say about this kind of advertising:



William W. Cox
AMP, Incorporated
sells to industry

Says Mr. Cox:

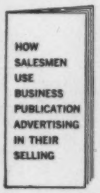
"The quickest way we can introduce a product is by introducing it through advertising in business papers. That way we get it around faster than we can by word of mouth alone. On occasion my home office has inquiries out to me before I can get to the customer or prospect to introduce a new product. They've already seen it in a trade magazine.

"It's interesting to note that within the last two weeks I received a survey which shows about 80% of the new customers we get on our books come through our trade publication advertising. Of course, our company is only 15 years old and we have grown from what you might say, *nothing*, to the biggest in our business. Certainly a lot of that has come from our advertising campaigns. Our name is known throughout the world right now, purely because of our advertising program. When I go to a prospect now, they know my company, they know my product ... it makes my job easier, and opens doors when I have to make cold calls."

Ask your own salesmen what your company's business publication advertising does for them. If their answers are generally favorable you can be sure that your business publication advertising is really helping them sell. If too many answers are negative it could well pay you to review your advertising objectives—and to make sure the publications that carry your advertising are read by the men who must be sold.

How salesmen use their companies' advertising to get more business

Here's a useful and effective package of ideas for the sales manager, advertising manager or agency man who would like to get more horsepower out of his advertising. Send for a free copy of the pocket size booklet entitled, "How Salesmen Use Advertising in Their Selling," which reports the successful methods employed by eleven salesmen who tell how they get more value out of their companies' advertising.



You'll find represented many interesting variations in how they do this. Some are very ingenious; all are effective. You can be sure that more of your salesmen will use your advertising after they read how others get business through these simple methods.

The coupon is for your convenience in sending for your free copy. Then, if you decide you want to provide your salesmen with additional copies, they are available from NBP Headquarters in Washington, at twenty-five cents each. Or if you choose you can reprint the material yourself and distribute it as widely as you please. But first, send for your free copy.

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PB131062. Preparation of Protective Coatings by Electrophoretic Methods. 46 *pages,* $1.50 *per copy.*

PB131093. Improvement of the Impact Resistance of Cermets. 27 *pages,* $1.00 *per copy.*

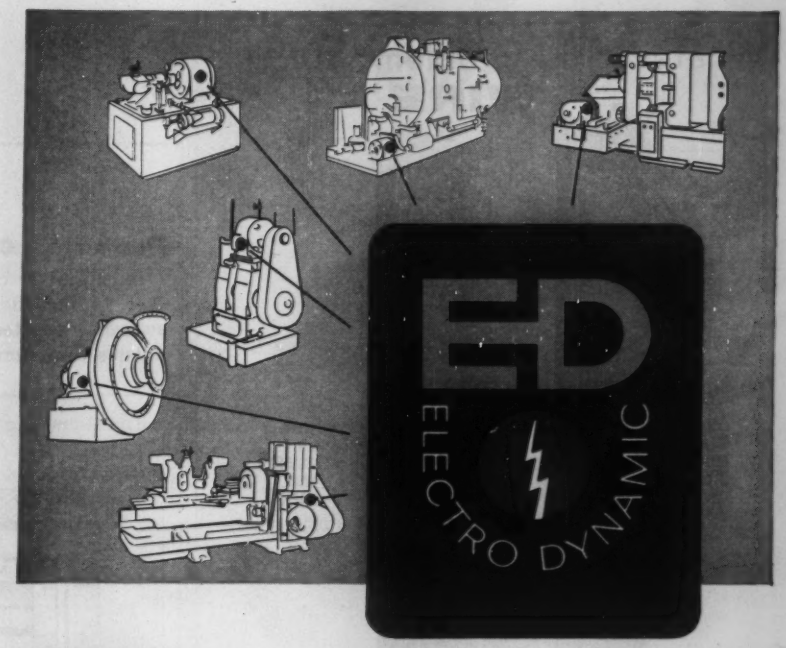
Joining of Molybdenum, WADC Technical Report 54-17, Part 2, PB111833. *By W. N. Platte, Westinghouse Research Laboratories;* 118 *pages,* 8¼ *by* 10¾ *in., paperbound; published by Wright Air Development Center, available from Office of Technical Services, U. S. Dept. of Commerce, Washington* 25, *D. C.;* $3.25 *per copy.*

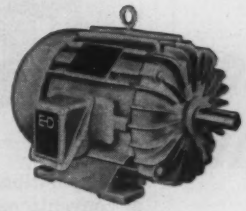
This report describes factors which influence physical properties, especially ductility, of molybdenum welds. Welds are studied in both arc-cast and vacuum-sintered molybdenum made in commercially pure inert atmospheres and contaminated atmospheres.

Effects of deoxidizers on welding properties of vacuum-sintered molybdenum are also examined as well as effects of interstitial elements on weld properties of arc-cast molybdenum.

Correction: Cast Metals Handbook, reviewed in the Engineer's Library, MACHINE DESIGN, October 17, 1957, is an American Foundrymen's Society publication and is not authored by Gustav Lieby as stated.

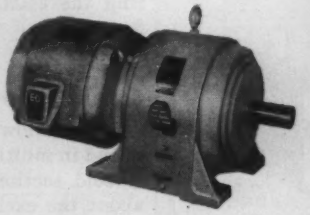
The translation of the German book **Design of Die Castings** by Gustav Lieby was reviewed in the Engineer's Library, MACHINE DESIGN, September 19, 1957.





STANDARD MOTORS

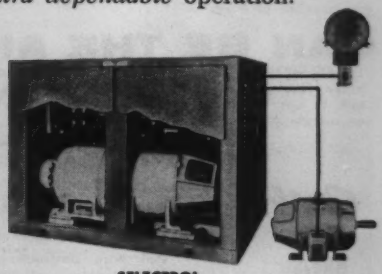
THIS EMBLEM IDENTIFIES EXTRA DEPENDABLE INDUSTRIAL MACHINERY



GEAR-ED-MOTORS

The red *power spot* on industrial machinery means "Powered by Electro Dynamic." Such machinery relies with confidence on the *extra dependability* of Electro Dynamic motors, the proven industrial motors which give industrial equipment *extra dependable* operation.

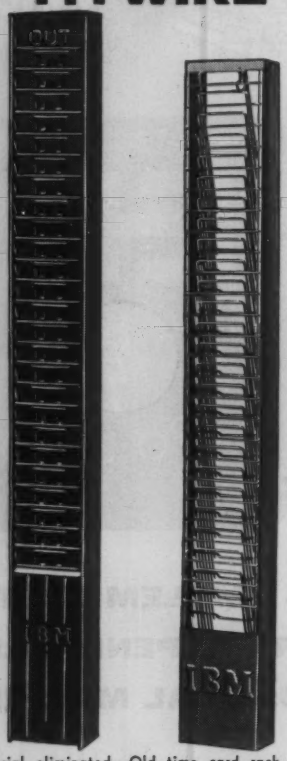
SELECTRON VARIABLE-SPEED DRIVES



SELECTROL VARIABLE-SPEED DRIVES

ELECTRO DYNAMIC
DIVISION OF GENERAL DYNAMICS CORPORATION
BAYONNE, NEW JERSEY

Whatever the problem or part ... WIRE

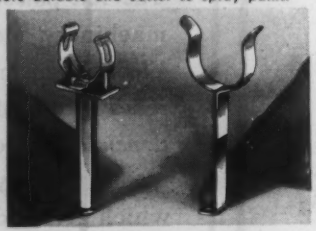


OLD STYLE SHEET STEEL RACK

NEW E.H.T. REDESIGNED WIRE RACK

Critical material eliminated—Old time card rack was made of scarce sheet metal. Titchener suggested a wire rack. The result . . . a rack 2 pounds lighter, more durable and easier to spray paint.

... or STRIP



Production time cut—Old radio bracket consisted of 6 parts . . . all assembled on the production line. Titchener engineers designed a welded steel strip unit. The result . . . less production time, only one part to inventory, and a saving per bracket of 4.7¢.

CAN BE THE ANSWER

LEARN HOW you can cut your costs, ease material shortages, and improve your product with Wire/Strip assemblies. Visit our plant and talk to our Wire/Strip experts . . . or send a drawing, photograph or sample of your product. There's no charge or obligation.

Free Wire/Strip Books! Send coupon

E. H. TITCHENER & CO.
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Dept. 3304, 67 Clinton St., Binghamton, N.Y.

Please send me your FREE Book(s)

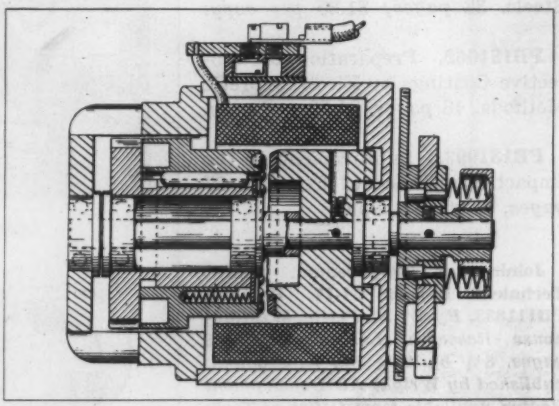
- ☐ "How Wire Construction Reduces Costs"
- ☐ "Wire Handles by Titchener".
- ☐ "Use of Wire Construction in Product Design"
- ☐ Please have a Titchener Field Engineer call.

NAME TITLE
COMPANY
STREET
CITY STATE

Noteworthy

Elastic-Plate Clutch

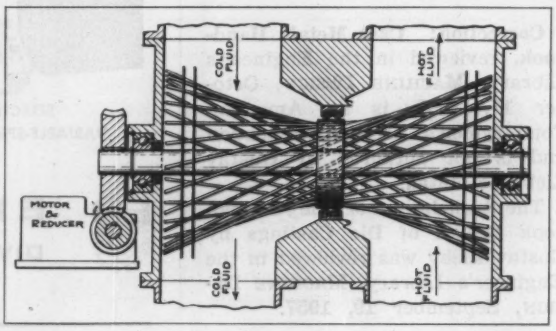
Spherical teeth sink axially into an elastic mating face to provide smooth, noiseless engagement in a solenoid-operated clutch designed for computing mechanisms and similar precision devices. Action elimi-



nates positional errors introduced when jaws or teeth of conventional-type clutches interlock. Because teeth of unit are rounded, an indefinite number of make-and-break operations is possible without cutting or marring the elastic face. . . *Patent 2,757,768 assigned to Sperry Rand Corp. by Hugo Landerer.*

Rotary Heat Exchanger

Captive low-melting-point alloy, sloshing from end to end in multiple hollow tubes, transfers heat from hot to cold sections in a rotary heat exchanger. Rotated about the exchanger axis by an external drive motor, skewed tubes making up the bundle are, in effect, tilted back and forth as they rotate. Result is to cause molten metal, which has picked up heat in the hot section (right), to flow by gravity to the cold section (left). Identical action brings the cooler metal to the hot section. Device, which operates

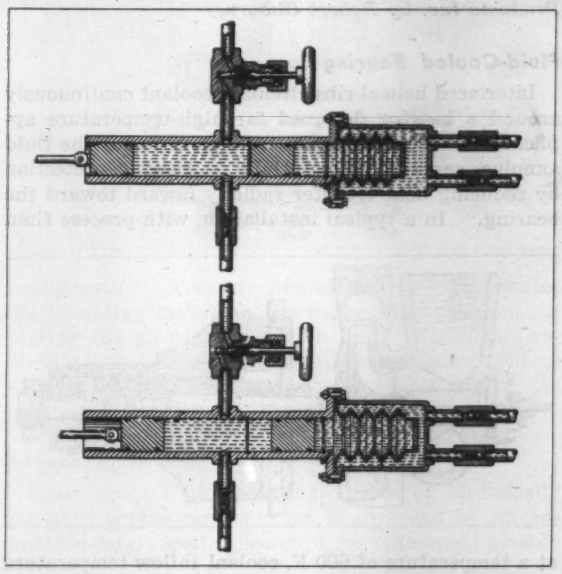


Patents

without auxiliary molten-metal pumps, finds typical use as a gas-turbine regenerating heat exchanger. *Patent 2,746,725 assigned to Cooper-Bessemer Corp. by Nelson G. Reed.*

Adjustable-Displacement Pump

Controlled bleeding of a liquid column, separating driving and free-floating pistons, provides the flow-regulating feature in an adjustable-displacement pump. On the pressure stroke of the driving piston (lower left), a predetermined part of the liquid in



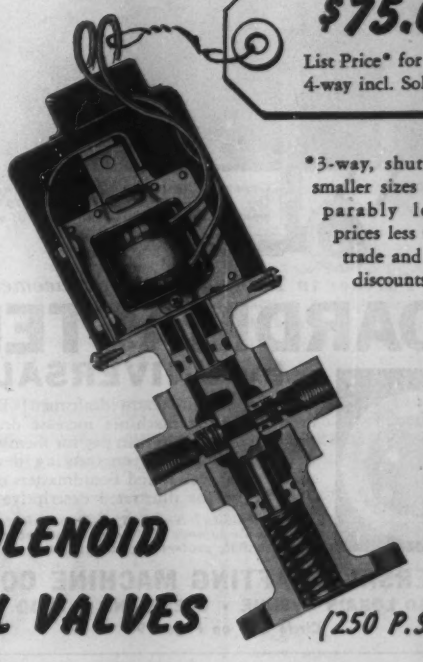
the column is allowed to escape, while the remainder displaces the free piston. Fluid bled from the column is automatically replaced during the suction stroke. In the model shown, pump components are separated from the pumped media by a flexible bellows which moves with the free piston. Unit is therefore well adapted for use with corrosive or explosive fluids. *Patent 2,807,215 assigned to Crane Packing Co. by Stephen Hawxhurst.*

Carbon-Ring Seal

Axial sealing contact between rotating carbon packing rings and stationary metal mating rings is provided by thin disc springs in a carbon-ring seal. Initially flat, the spring discs are deflected by projecting ribs on the packing-ring faces during assembly of the unit. Radial sealing contact between carbon rings and shaft is maintained by an encircling band. Axial force provided by the spring discs can be con-

LEAKPROOF (SHEAR SEAL)

$75.00
List Price* for a ½" 4-way incl. Solenoid



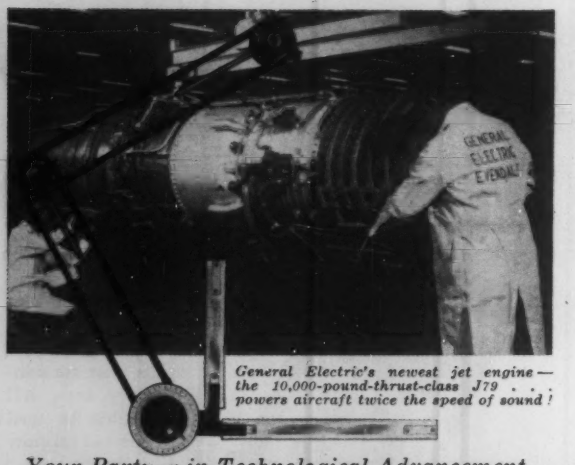
*3-way, shut-off and smaller sizes are comparably less. All prices less the usual trade and quantity discounts.

SOLENOID OIL VALVES (250 P.S.I.)

WHERE	WHY	HOW
Thread rolling machines	Holding position (leakproof)	Lapped sealing surfaces seal tight indefinitely as a result of wear compensation
Pressure testing in automotive production	Oil gets contaminated by scale in castings (not critical to dirt) reduced maintenance	Sealing surfaces in constant, intimate contact, dirt can't lock valving members – saves coil burn-out
Hydraulic work feed apparatus	(Leakproof) ... as versus spool valves which cause over-demand on hydraulic system	Positive shut off of internal port to port leakage and of course, no external leakage
Machine tool chucking & clamping	Maintaining safe holding pressure (leakproof)	Saving auxiliary equipment such as pilot operated check valves
Automatic door openers	Quick action (high flow capacity)	No spools or poppets obstructing full, round flow passages
Solenoid controlled hydraulic system on machine you build	Better performance	Shear-Seal valves have full flow, are leakproof, not sensitive to dirt
	Lower manufacturing costs	Low priced, less auxiliary equipment and labor cost.
	Reduce service problems	Valves don't stick, saving coil burn-out; stay leakproof indefinitely, seals are wear compensating

BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California
Ask for bulletin 5S-H



General Electric's newest jet engine—the 10,000-pound-thrust-class J79 . . . powers aircraft twice the speed of sound!

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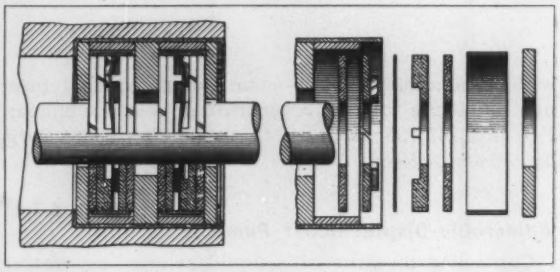
Circle 535 on Page 19

TRU-O-SEAL
STOPS
PIPE THREAD
LEAKS
TEFLON SEAL
PAT. PENDING
Satisfaction Guaranteed Or Money Back TRIAL OFFER
Tru-O-Seal Fittings are guaranteed to seal pipe thread connections permanently against all oils, practically all known chemicals and gases; to seal under high pressures or vacuum; to withstand —280° to plus 500° F.; to eliminate "overtightening" damage and pipe dope. Available in ⅛" to 2½" pipe thread sizes.
$10.00 Trial Offer No. 1: eight ⅛", ten ¼", eight ⅜", ten ½" pipe thread Tru-O-Seal Fittings.
$10.00 Trial Offer No. 2: eight ½", ten ¾", four 1" pipe thread Tru-O-Seal Fittings.
Send order to
TRU-O-SEAL DIVISION
Flick-Reedy Corp
2006 N. Hawthorne Melrose Park, Ill.
"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.
1 Thread Tru-O-Seal on pipe or fitting (no messy pipe "dope" needed).
SEAL SIDE
2 Thread pipe or fitting 4 threads into port. Point in desired direction.
3 Tighten Tru-O-Seal to complete leakproof assembly (only light torque required).

Noteworthy Patents

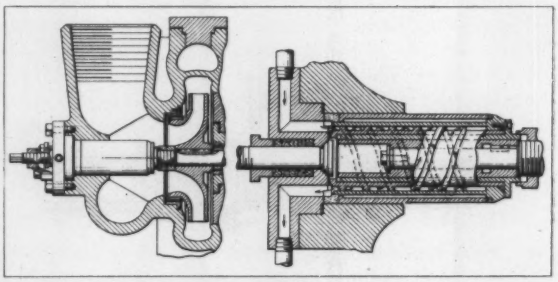
trolled relative to the clamping action of the band to provide any desired slippage between shaft and rings, or to modify the relative rubbing velocity be-



tween rings and mating faces. Shown here is a dual-section seal installation (left), comprising two sets of the components shown in the exploded view (right). *Patent 2,744,773 assigned to Thompson Products Inc. by Robert Cliborn.*

Fluid-Cooled Bearing

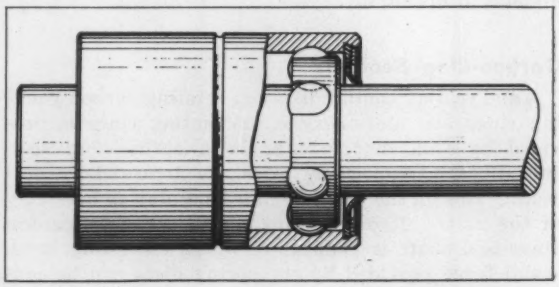
Interlaced helical ribs circulate coolant continuously around a bearing designed for high-temperature application. Dead air space, which surrounds the fluid annulus, contributes materially to bearing protection by reducing heat transfer radially inward toward the bearing. In a typical installation, with process fluid



at a temperature of 600 F, coolant inflow temperature was 65 F, and outflow temperature was 140 F. *Patent 2,744,796 assigned to Pacific Pumps Inc. by Michael E. Walters.*

Radial Seal

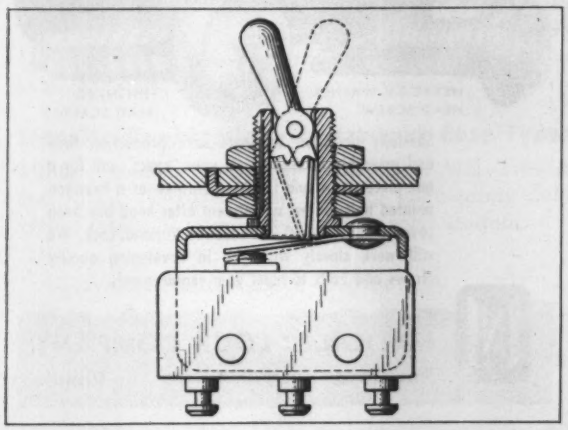
Flexure of a dished sealing element in a radial seal accommodates shaft misalignment or runout with minimum service wear. Fabricated of nylon or an



equivalent plastic, the washer has a glossy-surface sealing lip to provide reduced frictional resistance against the shaft. Initial ID of the washer is made slightly smaller than the shaft OD, insuring effective sealing contact. *Patent* 2,743,119 *assigned to Federal Bearings Co. Inc. by Don N. Covert and Ray L. Denney.*

Switch Actuator

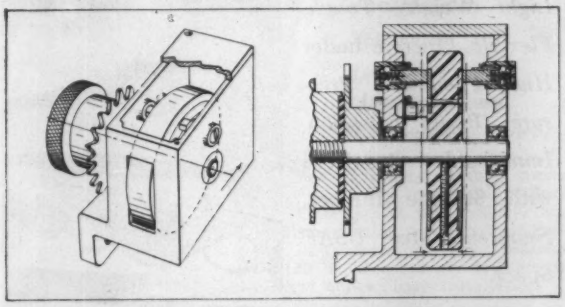
For providing momentary contact with minimum mechanical complexity, a lever-operated switch actuator is designed for use with conventional snap-action switches. Solid lines in sketch illustrate locations of operating lever and spring in normal or "off" switch



configuration. Pressure applied to the lever rotates the operating spring to the dashed-line position, actuating the snap-action switch unit. Mechanism returns to normal position when lever is released. *Patent* 2,808,480 *assigned to Electro-Snap Switch & Mfg. Co. by Manna D. Case and Eugene C. Connelly.*

Sequence Switch

Close control of operating cycles of electrically actuated brakes and clutches is provided by an adjustable rotary switch designed for high-speed presses



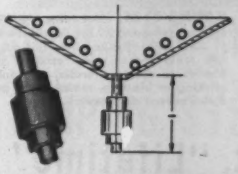
and similar machines. Conductive segments, spaced on the sides of a rotating insulated disc, contact spring-loaded brushes to establish programmed electrical continuity through the unit. Drive sprocket, which co-ordinates rotation of the switch with motion of the controlled machine, can be released by a knurled nut to permit adjustment of the disc. *Patent* 2,792,460 *assigned to Perkins Machine Co. by Thomas M. Bleeze.*

The Lepel line of induction heating equipment represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating.

If you are interested in induction heating you are invited to send samples of the work with specifications. Our engineers will process and return the completed job with full data and recommendations without any cost or obligations.

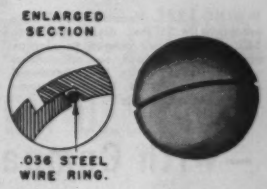
TYPICAL INDUCTION HEATING APPLICATIONS

TEMPERING FOR CUSTOM HEAT TREATING



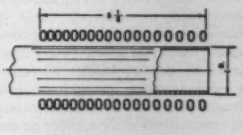
Selected areas of hardened steel parts may be tempered for fabrication or service requirements. Concentrator type coil permits high power density in restricted area thus minimizing heating time and permitting marked variation in properties in adjacent sections.

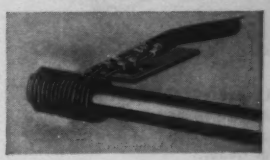
WIRE RING JOINS PLASTIC PARTS



High frequency induction heats wire ring which in turn heats plastic wall, providing sufficient plasticity to cause flow and bonding upon application of pressure. Metal to plastic seals are similarly performed.

ANNEALING ALUMINUM FURNITURE TUBING





Selective annealing of aluminum furniture tubing permits bending where required without loss of strength in adjacent portions of tube. Brass or steel tubing is also being selectively annealed.

Electronic Tube Generators from 1 kw to 100 kw.
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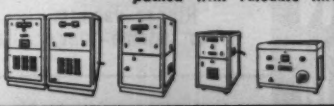

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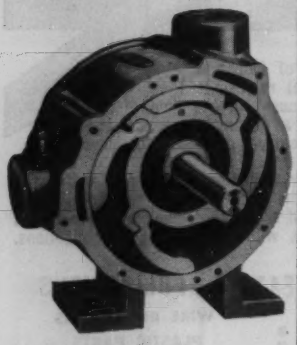
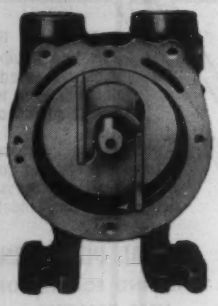
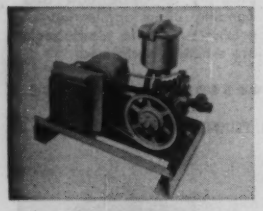


4-WING TYPE. Vacuums to 20" Hg.; pressures to 15 lbs.; displacement to 162 c.f.m. Wings hinged to pistons maintain continuous sealed contact with cylinder walls by centrifugal force. Small pistons, large air chambers, greater capacity.



2-WING TYPE. Vacuums to 29.9" Hg.; pressures to 20 lbs.; displacement to 40.8 c.f.m. Automatic wing adjusting lever forces wear-resistant steel blades to cylinder walls, preventing sticking or binding, maintaining positive vacuum or pressure.

—with Compact, "Lifetime"
LEIMAN *Rotary* AIR PUMPS



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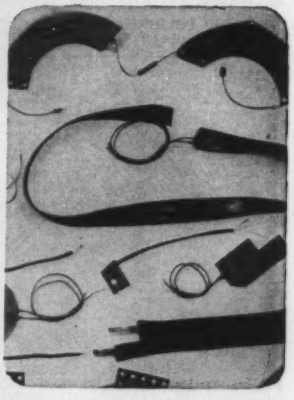

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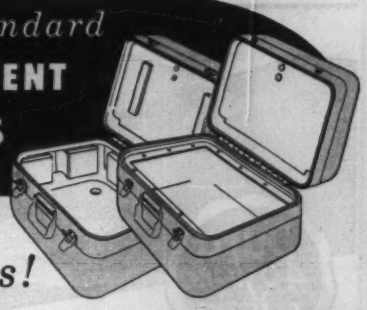

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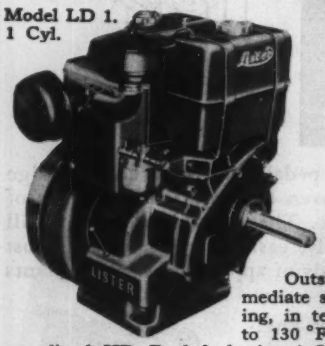

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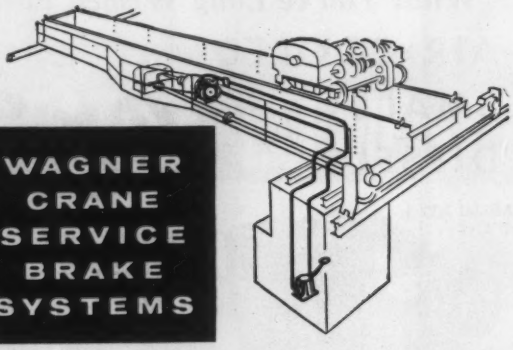

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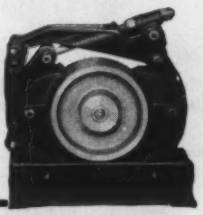

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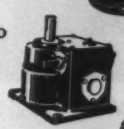

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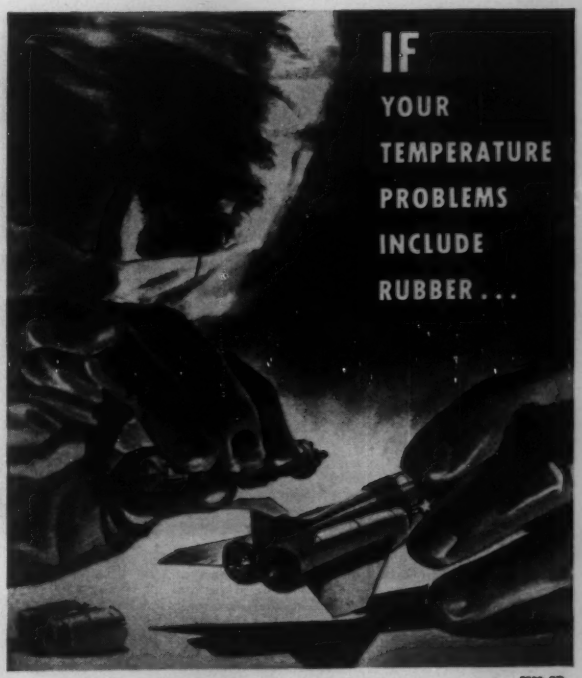

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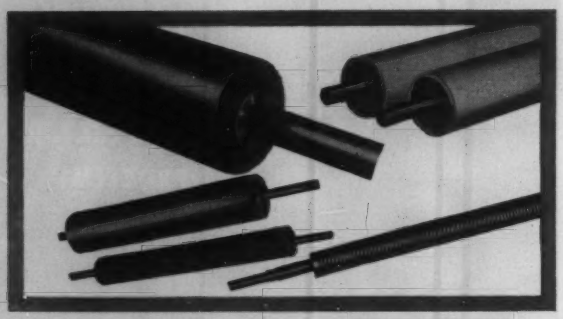

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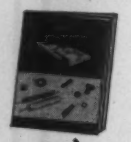

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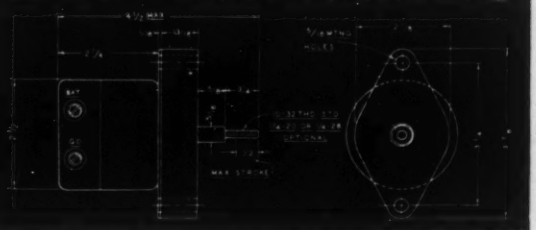

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are for operating engine throttles, fuel pump racks, chokes, etc. and are available with several variations.

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PULL
Approximately 10 lbs. over ½" stroke

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THEY FIT *electrically*

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• Every Comar relay is custom-designed exactly to fit your requirements. It has precisely the electrical characteristics, the physical size, the mounting, demanded by your specifications. Yet, this "custom-fitting" costs no more than ordinary relays. Inquiries invited.

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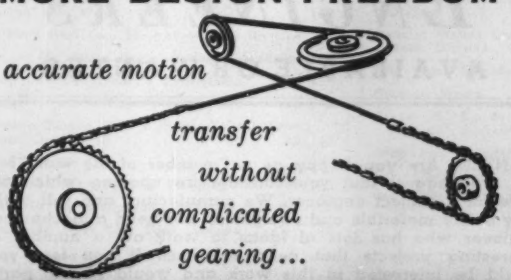

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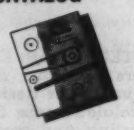

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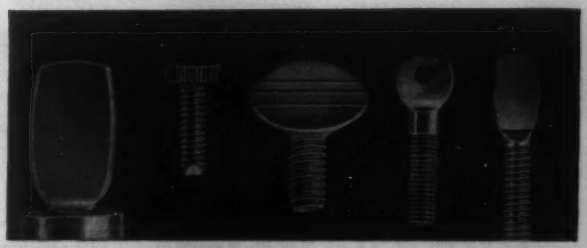

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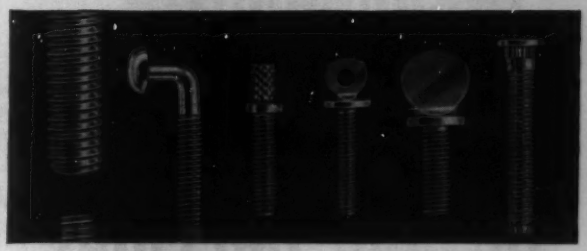
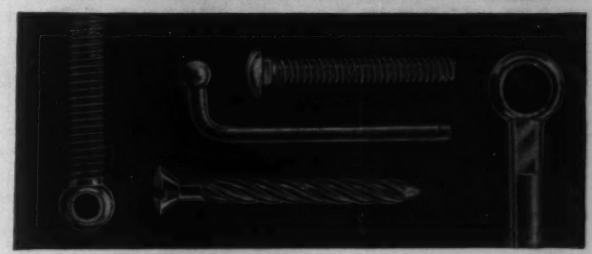


FOR PARTS LIKE THESE—AND



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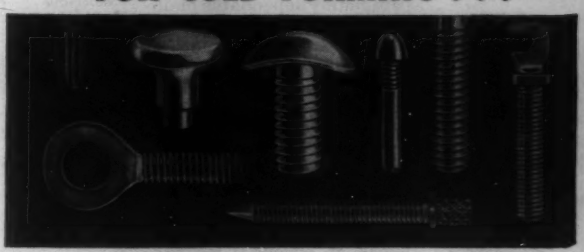

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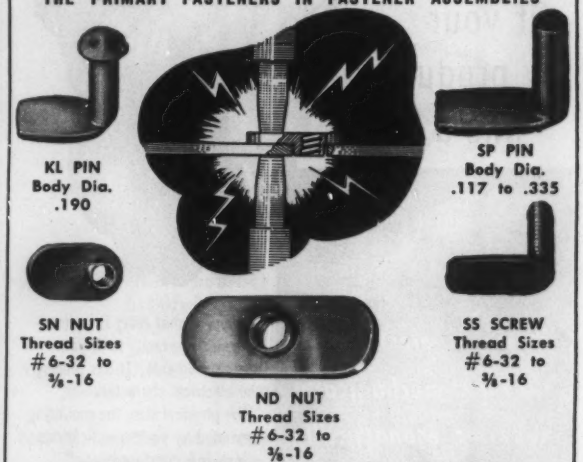
OHIO SPOT WELDING FASTENERS

THE PRIMARY FASTENERS IN FASTENER ASSEMBLIES



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OVER 50 YEARS OF BETTER FASTENING

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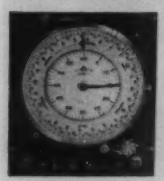

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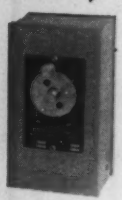

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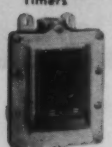

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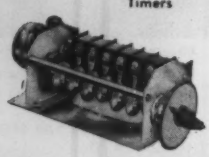

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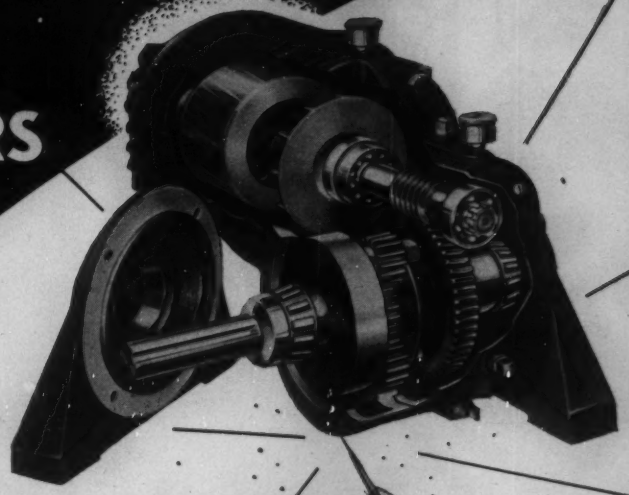
FOR ENGINEERS TO EXPRESS THAT



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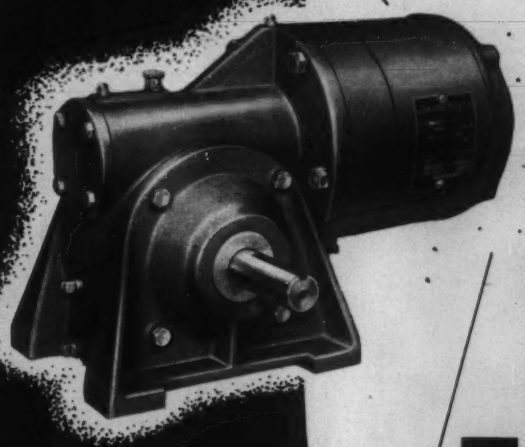

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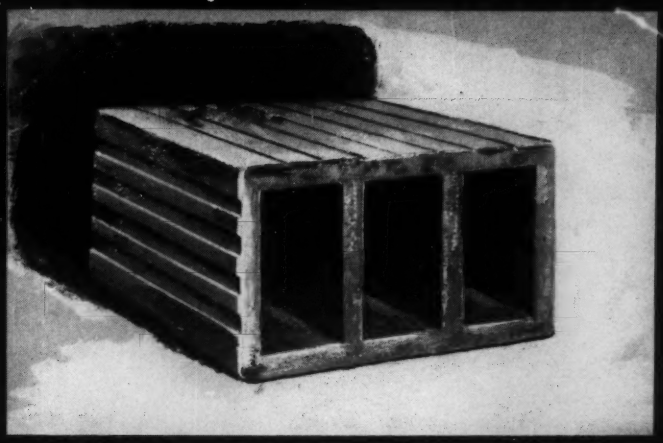

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